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To the Graduate Council:

I am submitting herewith a thesis written by Robert M. Teter, Jr., entitled "A Factor Analytic Study of Physical Testing Technicians in the Plastics Industry." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Industrial Management.

John M. Larson

Major Professor

We have read this thesis and recommend its acceptance:

Harold H. Whittaker

W. W. Goodman

Accepted for the Council:

Hilton A. Smith

Vice Chancellor for
Graduate Studies and Research

147

A FACTOR ANALYTIC STUDY OF PHYSICAL TESTING TECHNICIANS IN THE PLASTICS INDUSTRY

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Robert M. Teter, Jr.

June 1973

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Finally, mention must be made of my wife, Arlene, whose moral support and encouragement resulted in completion of the objectives.

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ABSTRACT

The objective of the study was to identify the factors which underlie the job of physical testing technician in the plastics industry and to evaluate quantitatively the elements which compose this job such that the content of a training program designed to impart fundamental skills could be determined.

A questionnaire containing 286 job elements was completed by 419 physical testing technicians and supervisors in 101 companies. For adaptation to computer programming the 286 job elements were divided into two distinct data sets prior to factor analysis by including alternate responses in each data set. Pearson product-moment correlations of a given item in every questionnaire with all remaining items in the particular data set were computed. A principal-axis factor analysis was then performed on each data set using estimated communalities. The scree test, supplemented by comparisons of factor loadings, was used to determine the number of salient factors. The factors emerging from each data set were then correlated for agreement in identity.

The names given the seven factors that emerged were, in decreasing order of the percent of variance accounted for, Mechanical Tests (A), Exoteric Functions, Chemical Tests, Mechanical Tests (B), Esoteric, Nontechnical Functions, Plastic Materials, and Intrinsic Property Tests. These factors were contrasted with the organization of the current questionnaire. A distinction was made between statistical importance,

as revealed by factor loadings, and absolute importance, as revealed by means. The utility of the results with respect to training was discussed and recommendations were made concerning their implementation. It was concluded that the seven factors could be viewed as a curriculum outline with the job elements having high means being indicative of specific course content.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
	General Introduction	1
	Training project for physical testing technicians	1
	The Problem	2
	Statement of the problem	2
	Importance of the study	3
	Scope of the study	4
	Method of Procedure and Sources of Data	5
	Definitions of Terms Used	6
	Organization of the Study	7
II.	HISTORY	8
	General	8
	Review of the Literature	8
	Literature related to methodological similarities	9
	Literature related to physical testing technicians	11
	Definitions of Physical Testing Technician	14
III.	METHODOLOGY	16
	Opening Statement	16
	Description of the Questionnaire	17
	Organization	17
	Method of response	19

CHAPTER PAGE

Administration of the Questionnaire 19
The Analysis 20
Objective of factor analysis 20
The principal-axis method 21
Treatment of the data 22
IV. RESULTS 25
Demographic Information 25
Age and sex 25
Job title 25
Primary responsibility 25
Education 26
Experience 26
Job duties 26
The Factors 26
Factor 1, odd-numbered responses 26
Factor 2, odd-numbered responses 28
Factor 3, odd-numbered responses 28
Factor 4, odd-numbered responses 32
Factor 5, odd-numbered responses 32
Factor 6, odd-numbered responses 32
Factor 7, odd-numbered responses 36
Factor 1, even-numbered responses 36
Factor 2, even-numbered responses 36
Factor 3, even-numbered responses 41

CHAPTER PAGE

Factor 4, even-numbered responses 41
Factor 5, even-numbered responses 41
Factor 6, even-numbered responses 45
Factor 7, even-numbered responses 45
The Correlation of Factors 48
Factor 1 48
Factor 2 48
Factor 3 48
Factor 4 48
Factor 5 48
Factor 6 48
Factor 7 49
V. DISCUSSION 50
Determination of the Number of Factors 50
Selection of the Factor Loading Criterion 54
General Comment on the Sample 54
Comparison with Valentine's Findings 55
Factor 1, Mechanical Tests (A) 56
Factor 2, Exoteric Functions 56
Factor 3, Chemical Tests 57
Factor 4, Mechanical Tests (B) 57
Factor 5, Exoteric, Nontechnical Functions 58
Factor 6, Plastic Materials 59
Factor 7, Intrinsic Property Tests 59

CHAPTER PAGE

Summary 59

Implication of Results for Training 62

Statistical versus absolute importance 65

Recommendations 66

VI. SUMMARY AND CONCLUSION 68

LIST OF REFERENCES 71

APPENDIXES 75

Appendix A 76

Appendix B 97

Appendix C 100

VITA 105

LIST OF TABLES

TABLE		PAGE
1.	Categories of the Job Elements	18
2.	Factor Loadings and Means for Items on Factor 1, Odd-Numbered Responses; Mechanical Tests (A)	27
3.	Factor Loadings and Means for Items on Factor 2, Odd-Numbered Responses; Exoteric Functions	29
4.	Factor Loadings and Means for Items on Factor 3, Odd-Numbered Responses; Chemical Tests	31
5.	Factor Loadings and Means for Items on Factor 4, Odd-Numbered Responses; Mechanical Tests (B)	33
6.	Factor Loadings and Means for Items on Factor 5, Odd-Numbered Responses; Esoteric, Nontechnical Functions	34
7.	Factor Loadings and Means for Items on Factor 6, Odd-Numbered Responses; Plastic Materials	35
8.	Factor Loadings and Means for Items on Factor 7, Odd-Numbered Responses; Intrinsic Property Tests	37
9.	Factor Loadings and Means for Items on Factor 1, Even-Numbered Responses; Mechanical Tests (A)	38
10.	Factor Loadings and Means for Items on Factor 2, Even-Numbered Responses; Exoteric Functions	39
11.	Factor Loadings and Means for Items on Factor 3, Even-Numbered Responses; Chemical Tests	42

TABLE PAGE

12. Factor Loadings and Means for Items on Factor 4, Even-Numbered Responses; Plastic Materials 43

13. Factor Loadings and Means for Items on Factor 3, Even-Numbered Responses; Estoteric, Nontechnical Functions . . 44

14. Factor Loadings and Means for Items on Factor 6, Even-Numbered Responses; Mechanical Tests (B) 46

15. Factor Loadings and Means for Items on Factor 7, Even-Numbered Responses; Intrinsic Property Tests 47

16. Eigenvalues, Differences and Percent of Variance for 20 Factors, Odd-Numbered Responses 52

17. Eigenvalues, Differences, and Percent of Variance for 20 Factors, Even-Numbered Responses 53

18. Items with Means over 2.50 which Loaded above 0.350 on None of the Factors 63

19. Means of the Item Means for Each Factor 64

20. Varimax Matrix, Odd-Numbered Responses 77

21. Varimax Matrix, Even-Numbered Responses 82

22. Third Ordered Promax Matrix, Odd-Numbered Responses 87

23. Third Ordered Promax Matrix, Even-Numbered Responses 92

24. Participating Organizations and Their Locations Listed Alphabetically 101

CHAPTER I

INTRODUCTION

General Introduction

In 1966, Oak Ridge Associated Universities (ORAU) began providing worker training in six occupations: (1) welder, (2) glass blower, (3) machinist, (4) electronics technician, (5) mechanical draftsman, and (6) physical testing technician. The ORAU coordinated the project funded through interagency agreements with the Atomic Energy Commission to locate the training school, called Training and Technology (TAT), in Oak Ridge, Tennessee. The project is intended to teach unemployed and underemployed persons the skills which will qualify them for jobs in which there are shortages of workers.

The occupation of physical testing technicians has become a concern to several professional organizations in the dynamic plastics industry. The Society of Plastics Engineers (SPE) sponsors an Education Committee which is concerned with plastics education at technical and secondary school levels as well as at the college level. SPE has supported the efforts of the Plastics Education Foundation with career guidance programs for schools from secondary through graduate education levels.

Training project for physical testing technicians. TAT has established a physical testing technician program to provide the trainee general familiarity with specific job functions in both destructive and

nondestructive testing and includes tests and specifications for both metals and nonmetals. The program intends to improve the unemployed and underemployed person to a level where he is a good candidate for a physical testing technician position. TAT is completely aware that the companies hiring these "trained" individuals will have to train them to do specific tasks, especially in the growing plastics industry.

A questionnaire was designed to determine: (1) the tasks involved in a physical testing technician's position in the plastics industry, and (2) the relative importance of these tasks to each other in a quantitative evaluation and ranking (Valentine, 1971, p. 3). The data used in this work were recorded responses of actively employed physical testing technicians and their supervisors (Valentine, 1971, p. 4). This thesis represents a quantitative factor analysis of the data collected thus far.

The Problem

Statement of the problem. The following were the objectives of this study:

1. To identify the factors which are most significant in the training of physical testing technicians represented in the plastics industry.
2. To conduct the study such that the results provide information relative to on-the-job requirements which have relevance as training bases.

Importance of the study. The initial step in the development of an effective training program is to analyze the job in which the trainee will be functioning, i.e., operations analysis.

> Operations analysis focuses on the task or job regardless of the employee performing that job. It includes a determination of what an employee must do, the specific behavior required, if the job is to be performed effectively. Again, the focus is on the task, not the man. (MeGehee and Thayer, 1961, p. 3)

Every element of the job must be described and defined.

The dynamic plastics industry has made the training problem for technicians very difficult; since the industry is forever changing, any description and definition of the job of physical testing technician rapidly becomes outdated. The growth of the plastics industry is illustrated by the domestic production of synthetic plastics and resin materials over the past four years. In 1967, the U. S. production of synthetic plastics and resin materials was 13.8 billion pounds (Synthetic Organic Chemicals--United States Production and Sales, 1967, 1969, p. 37); in 1968, 16.4 billion pounds (Synthetic Organic Chemicals--United States Production and Sales, 1968, 1970, p. 141); in 1969, 18.7 billion pounds (Synthetic Organic Chemicals--United States Production and Sales, 1969, 1971, p. 133); and preliminary estimates indicate that 19.4 billion pounds will be produced in 1970 ("Preliminary Report on U. S. Production and Sales of Plastics and Resin Materials Revised Preliminary and December 1970 and January 1971," April 1971, pp. 1-3).

The problem of training physical testing technicians is further complicated by the addition of new plastic materials on the market.

It is believed that a large majority of the training presently being accomplished is on-the-job training and is slow to meet the demand of this progressive industry.

In order to design an adequate training program for physical testing technicians, it is of the utmost importance to gear the program to meet the needs of the industry. Emphasis must be placed on the areas of most general importance to the industry to make the program effective. To establish an adequate training program requires the complete and thorough inclusion of the most significant factors involved in the job along with inclusion of many general factors of importance.

Valentine arranged the elements of the questionnaire in eleven main groupings with one group having three significant subgroups for ease of administration (Valentine, 1971, p. 30). The groupings and subgroupings were arranged in order according to the overall mean. In attempting to factor analyze the data, it was worthwhile to compare the factors derived with Valentine's groupings. Since the questionnaire had been well conceived, some correlation was expected between these groupings and the factors extracted by the use of factor analysis. By careful analysis of the factors which result from this thesis and the ranking from Valentine's work, a "tag" should be applicable for each of the factors. Inclusion of these factors in a training program for physical testing technicians should benefit the entire plastics industry.

Scope of the study. The scope of this study included all phases of physical testing operations for plastics materials as covered by Committee D-20 on Plastics of the American Society of Testing and Materials. This

committee reports its standards in Part 26 and Part 27 of the ASTM Standards, which are published annually. The tasks covered in these two documents include practically all tests and evaluations generally recognized and used in the plastics industry in this country. The ASTM is the recognized source of information of this type since their information represents years of experience.

Phases of the technicians' jobs that were included in this study include sample and specimen preparation procedures and equipment; use of equipment, tools, and instruments in the various evaluations and tests; calculations; clerical duties; responsibilities; supervision given and required; results of errors; methodology and repetitive task requirements; physical and mental demands; and the knowledge, education and experience requirements.

This study was intended to isolate the most important factors in the job of physical testing technician for inclusion in an adequate training program.

Method of Procedure and Sources of Data

A questionnaire was prepared listing approximately 300 individual job elements or tasks required of a physical testing technician. The information was derived by listing those tasks required to perform the standard tests and evaluations on plastics sanctioned by ASTM D-20. The questionnaire was submitted to ASTM for distribution to the 400 members of Committee D-20 on Plastics. In addition to job elements, the respondents were requested to complete a personal data sheet including name,

age, specialty, position (technician or supervisor), and company affiliation (Valentine, 1971, pp. 2-4).

Respondents were requested to weigh numerically each job task on a scale ranging from zero to seven, indicating whether the task is "definitely not part of the job" (mark "0"), "a significant part of the job" (mark "5"), or intermediate in importance (Valentine, 1971, pp. 3-4).

Approximately 400 questionnaires have been returned to date, and these questionnaires were compiled, organized, and analyzed by factor analysis. The objective of the factor analysis work was to account for the common variance among a set of measurements. Data from the physical testing technician questionnaires were factor analyzed by the principal-axis method for two reasons: (1) the availability of a standard computer program and (2) the inherent technical advantages of the principal-axis method over other methods.

Definitions of Terms Used

The plastics industry is defined to include those enterprises which are engaged in the manufacture, processing, and handling of material "that contains as an essential ingredient an organic substance of large molecular weight, is solid in its finished state, and at some stage in its manufacture or in its processing into finished articles, can be shaped by flow (1968 Book of ASTM Standards, Part 27, 1968, p. 379).

A physical testing technician, for the purpose of this study, is defined as a person engaged directly in the preparation of plastic samples and specimens for testing and in the testing and evaluation of

plastic materials for purposes of quality control, research, development, or technical service.

Organization of the Study

Chapter I includes the introductory statements, the problem, the importance of the study, the scope of the study, the methods of procedure, the sources of data, definitions of terms used, and the organization of the study.

Chapter II includes a brief history of plastics technology and the demand for physical testing technicians. Also included in this chapter is a literature review on the information currently available in the subject area.

Chapter III contains the methodology and procedures used to complete this study. A sample questionnaire as presented to the respondents is enclosed.

Chapter IV contains the results from the principal-axis method of factor analysis. The significant factors are examined in depth.

Chapter V exhibits the discussion and implications of the results.

Chapter VI exhibits the summary and conclusion.

CHAPTER II

HISTORY

General

The plastics industry--a youthful industry--is growing more rapidly than most other industries and is expanding at an astonishing rate both in the number of different materials available commercially and in the fields of their application. Although Dr. Leo H. Backeland developed phenol-formaldehyde resins as the first synthetic molding material in 1908, plastics in the true sense have been with us since 1870 when the nitrates (Celluloid) were used for eyeglass frames (Simonds, 1957). The earliest moldings apparently resulted when John W. and Isaiah S. Hyatt used a stuffing machine in 1870 to mold rubber. Later use of the Hyatts' patent led to the utilization of cellulose acetate extrusions in 1919 by Dr. Arthur Eichengrun. Plastics became serious work with the introduction of the acrylics in 1934. Polyvinyl chloride (PVC) was developed extensively during World War II as a rubber substitute and was boosted by the development of castable or moldable liquid dispersions in the late 1940's. Recent growth trends in the polyolefin, polystyrene, and polyester plastics have resulted in plastic applications in almost all segments of the economy (Plastics Engineering Handbook, 1970).

Review of the Literature

The library research for this thesis has been conducted with two purposes in mind: (a) an attempt was made to review those studies with

methodological similarities to the present study regardless of the types of jobs investigated, and (b) a review was made of the research directly related to determining the composition of the job of physical testing technicians in the plastics industry.

Literature related to methodological similarities. The task of identifying the components of a job is an important aspect in developing a training program as well as in performing other personnel functions related to that job. Factorial methods of analysis can be a useful tool to aid in the accomplishment of this task. For example, Howard and Schutz (1952), Lawshe, Dudek, and Wilson (1948), and Lawshe and Satter (1944) have demonstrated the use of factorial methods for the identification of job components.

Over the years, much has been done to confirm the idea that basic dimensions or aspects of work activity can be identified. Some of the early works (Coombs and Satter, 1949; McCormick, Finn, and Scheips, 1957) were broad in that they dealt with families of jobs. As an example, the object of the study by McCormick, Finn, and Scheips was to determine the patterns of job requirements of 4,000 jobs which had been analyzed in terms of 44 variables by U. S. Employment Service job analysts. By the use of Hotelling's principal--axis method of factor analysis, seven factors were identified. The jobs were then classified, according to factor scores, into patterns of job requirements; and most jobs were found to be in a limited number of the various possible patterns. Another broad study was Palmer's and McCormick's (1961) use of

factor analysis to analyze a 177-item checklist describing the work behaviors of 250 salaried, clerical, and hourly jobs in a large steel-producing firm. This study, using the multiple-group method with communalities based on the highest correlations, produced 14 factors.

The study with methodology most closely related to the present study is that of Grove (1968). Grove carried the efforts of Degli (1967) through a factor analysis using the principal-axis method. The method of rotation used by Grove was the varimax (orthogonal) rotation. Both the works of Degli and Grove can be traced to the Hemphill (1959) effort to describe executive positions through use of a comprehensive questionnaire listing small elements of the total job function. Hemphill had 93 executives in five companies report the extent to which each of 575 job elements was a part of his job. The completed questionnaires were factor analyzed and 10 dimensions of executive positions identified. The Hemphill study was of particular interest since the methodology could easily be utilized for investigations of other jobs. Degli developed a questionnaire containing 289 job elements for the mechanical drafting position and solicited 102 responses to the questionnaire. The analysis by Degli was restricted to computing means and standard deviations for each response and indicating their relative importance to each other. Grove used factor analysis to further study the data gathered by Degli. Using some 1400 responses to the questionnaire, Grove identified 11 factors in his study. Grove concluded that Degli's work gave effective guidance on emphasis for subject matter in a training program for mechanical drafting; whereas, his own factor analysis revealed a need

for arrangement and organization of the subject matter. Grove also concluded that Degli's findings were inconclusive (Grove, p. 48). Grove was actually able to attach better identities to the items contained in each of the 11 sections of Degli's questionnaire. The names given the 11 factors extracted by Grove were more conclusive and independent than were the 11 sections used by Degli in his design for the questionnaire. Although Grove showed that the categorization scheme used by Degli could have been imporved, he also showed a good agreement as to which items on the questionnaire were important.

In conclusion, there is strong evidence that factor analysis can be used to identify the dimensions of a job. It is also worthy of mention to note that factor analysis can readily be applied when large numbers of items representing a particular domain need to be reduced to a small, but still appropriate, number of descriptors.

Literature related to physical testing technicians. A literature survey has revealed a distinct deficiency of empirical studies related to the job functions of technicians, particularly as related to physical testing technicians in the plastics industry. There also appears considerable disagreement over the definition for the technician job function, which has been reflected in design of programs for a "technical education" (Schaefer and McCord, 1963, p. 3). The Office of Education in the Federal government developed the following general definition of the technician:

> A general term applied to an individual who assists with the technical details in a trade or profession. Uses tools,

> instruments, and/or special devices to design, illustrate, fabricate, maintain, operate, and test objects, materials or equipment. Performs mathematical and scientific operations reporting on and/or carrying out a prescribed action in relation to them. Examines and evaluates plans, designs, and data; determines action to be taken on the basis of analysis; assists in determining or interpreting work procedures and maintaining harmonious relations among groups of workers. (Schaefer and McCord, 1963, p. 4)

The above description would seem more applicable than the definition for technicians offered by the Dictionary of Occupational Titles (1965, p. 728), which is directed toward electrical workers. The definition for tester (p. 732) is extremely close to the job function considered in this study. However, even this definition is limited to the tester working with metals with no mention being made of working with plastic materials.

Unfortunately, no clear understanding of the training requirements nor the utilization of technicians in the plastics industry, or other industries, exist. Graney (1964) reports on the lack of a commonly recognized job title for the technician; on the generally negative attitudes of educators towards the technical education, especially as offered by the technical institutes; and on the failure of engineers and scientists to effectively use technicians in their organizations.

In addition to the apparent lack of training tools for technicians, there seems to be a pattern relative to the lack of training programs offered. Franke and Sobel (1970) claim that most practitioners in the technical fields were upgraded into their current posts after employment at a lower level. Due to the flexible and relatively informal entry requirements, this type of on-the-job training appears to work. A

result of this type of "training" has been training programs which are restricted to satisfying the immediate needs of the organization rather than the overall demands of the labor market (Franke and Sobel, 1970, p. 296).

Several sources (Rhine and Creamer, 1969; Society of Plastics Engineers, Inc. (SPE), 1969 and 1970; Delia, 1969; Technical Education Yearbook, 1963) discuss generally the educational offerings available for technicians and the need for programs for technicians as specifically related to the plastics industry. The picture is not an attractive one for the plastics industry. Little, if any, attention is given in the literature to course content for physical testing technicians in the plastics industry.

By far, the research most closely related to the present study is that of Valentine (1971). In reality, the present study is but a logical extension of Valentine's, enhanced by a much more rigorous method of analysis. Valentine developed a questionnaire containing 296 job elements based principally on Hemphill's (1959) technique. The job elements, defined as statements describing some aspect of the job, were obtained primarily from two lengthy volumes, parts 26 and 27, of the 1971 Annual Book of ASTM Standards. A questionnaire was developed comprising these elements plus other job duties and information believed to be important to the technician. The proposed questionnaire was submitted to knowledgeable representatives of the plastics industry and to educators for a critique. The 296 elements in the revised questionnaire were then reviewed for proper content, format and ease of

completion by several technicians and their supervisors. The workable format realized for the questionnaire required approximately 30 minutes to complete. The respondent was instructed to indicate the importance of each element to his position utilizing a scale of zero to five in which zero meant it was definitely not part of his job duties, and five meant it was vital and utmost in his job performance.

The sample used for Valentine's work consisted of 419 questionnaires completed by physical testing technicians or their supervisors in 101 companies. Means and standard deviations of the items were computed, and an attempt was made to determine their relative importance. The results showed that items varied in importance with responses for all items varying from zero to five. It is also of importance that the standard deviations were generally quite large for responses to individual items. It is apparent that, though the methodology appeared sound, interpretation on the basis of means and standard deviations was difficult.

In discussing the implications of his study for further research, Valentine (1971, p. 42) suggested that "later research be implemented by means of factor analysis of the items in this questionnaire, in an effort to better identify the dimensions of the job."

Definitions of Physical Testing Technician

It seems appropriate to offer the following two definitions, in part, since they appear close enough to the job under consideration to be included here:

ANALYTICAL RESEARCH TECHNICIAN, RESINS AND ADHESIVES (Chem.) 008.380. special adhesive technician; technical plastics specialist. Sets up and operates laboratory--test apparatus to conduct physical and chemical tests of resins and adhesives to determine qualities, such as clarity, content of specific chemicals, or adhesiveness: Mixes sample batches of glue or resin according to formula. Operates apparatus to heat, compress, stretch, abrade, humidify, cut, bend, twist, or tear samples. Determines insulating qualities of samples, and tests samples to determine effects of aging and exposure to weather. May plan test projects and procedures, indicating required machines, tools, materials and time. (Dictionary of Occupational Titles, 1965, p. 14)

LABORATORY TESTER (any ind.) I.029.181 chemical analyst; chemist, assistant; laboratorian; laboratory man; laboratory sampler; research-laboratory technician; research technician; tester. Performs laboratory tests according to prescribed standards to determine chemical and physical characteristics or composition of solid, liquid, or gaseous materials and substances for purposes such as quality control, process control, product development, or determining conformity to specifications: Sets up and adjusts laboratory apparatus, and operates grinders, agitators, centrifuges, ovens, condensers, and vibrating screens to prepare material for testing according to established laboratory procedures. (Dictionary of Occupational Titles, 1965, p. 403).

CHAPTER III

METHODOLOGY

Opening Statement

Credit for devising the physical testing technician questionnaire and collecting the data used in this study belongs solely to Valentine (1971) and to ASTM, the supporting organization for the distribution of the questionnaire. The luxury of hindsight affords the opportunity to realize that certain portions of the questionnaire could have been improved for adaptation to factor analysis. For example, the questionnaire contains such a large number of items that the computerized data treatment was applied to one-half the data and then to the other half. Perhaps the Section "Tests" could have been reduced significantly by using more general items instead of the very explicit items used in the existing questionnaire.

Any criticisms, however, should not be interpreted as a lack of appreciation for either the ingenuity or the labor expended. To obtain a representative sample of physical testing technicians is, at best, a difficult task since so much disagreement exists with respect to a definition of this occupation. That efforts were directed through ASTM exemplifies the care and patience exhibited to collect the data. The diligent preparation and testing of the questionnaire resulted in a comprehensive and well-constructed document.

Description of the Questionnaire

Since a general description of the development of the questionnaire was given in Chapter II, emphasis here will be placed on its organizaton and the method of response.

Organization. Physically, the questionnaire was composed of eight sheets of 8-1/2 by 11-inch paper. The eight sheets of paper were divided into two sections of four pages each. The first section contained a cover letter from Mr. W. F. Hulse, staff assistant of ASTM, instructions for completing the questionnaire, and the job elements of the questionnaire. The first sheet of this section contained the cover letter of Mr. Hulse, addressed to D-20 committee members of ASTM; the back of this sheet contained instructions to the respondent and job elements for the first section of the questionnaire. The remaining three sheets of this section contained job elements on both front and back sides.

The second section of four 8-1/2 by 11-inch pages was the separate answer sheets. The first sheet of this section contained personal data--questions and answers both; the back of this sheet and the front and back of the remaining three pages contained the answer sheets. In addition, the upper portion of the back of the first page contained instructions for the proper use of the answer sheets.

The job elements were classified into 11 categories, as shown in Table 1. Demographic variables included in the questionnaire were company, location, age, sex, job title, primary responsibility, formal

TABLE 1

CATEGORIES OF THE JOB ELEMENTS

Category	Number of Elements
1. Plastics Materials	22
2. Sample Preparation	15
3. Tools and Equipment	27
4. Tests	127
5. Calculations	12
6. Clerical Duties	9
7. Responsibilities	14
8. Supervision Given and Received	19
9. Results of Errors	6
10. Physical and Mental Demands	13
11. Knowledge, Education and Experience	22
	286

education, vocational training, experience, and percent of time worked in job duties directly related to the physical testing of plastics.

Method of response. For each element, the respondent was instructed to circle the number best describing the importance of the element to his position on a zero-to-five scale. At the top of each page of the answer sheet section was a listing which defined the responses in such a way as to provide at least a rational continuum of increasing importance. The definitions were:

0 - Does not apply; - definitely not part of my job.

1 - Insignificant; - rarely encountered in my job.

2 - Minor importance; - encountered occasionally.

3 - Moderate importance; - frequently a part of my job.

4 - Very important; - a regularly occurring part of my job.

5 - Extremely important; - vital and utmost in my job performance.

An example of the completed questionnaire, along with the answer sheets, is shown in Appendix B.

Administration of the Questionnaire

Valentine (1971) attempted to secure a sample of physical testing technicians representing as many variations of the job as was possible. Three copies of the combined covering letter/questionnaire form plus six copies of the combined personal data/answer sheet form were mailed to each of the 400 members of ASTM D-20 Committee on Plastics. The use of separate questionnaire and answer sections permitted the use of the same questionnaire for more than one response. Recipients were also urged to

make additional copies of the answer sheets or to request additional answer sheets as required.

The original deadline for the return of the answer sheets was extended five weeks and included a follow-up letter urging participation. This extension resulted in the return of an additional 163 responses, making the total participation 419 individuals.

A total of 101 organizations from 26 states plus three Canadian provinces agreed to take part in the study. Appendix C lists the responding organizations and their locations. Approximately 40 percent of them are from the northeastern sector of the country, another 40 percent from the northern midwestern states (Great Lakes area), with the large portion of the remainder from the southern sector. The Far West and Canadian areas accounted for about 2 percent each.

The Analysis

Objective of factor analysis. The objective of factor analysis is to account for the common variance among a set of measurements. Fruchter (1954, p. 1) defines factor analysis as "a method of analyzing a set of observations from their intercorrelations to determine whether the variations represented can be accounted for adequately by a number of basic categories smaller than that with which the investigation was started." With respect to the physical testing technicians in the plastics industry study, this means that the domain of physical testing represented by the n job elements may in actuality be accounted for by m factors, where m is less than n. In such a case, the researcher is

aided by needing only to interpret a comparatively small number of factors as opposed to the enormous task of attempting to understand a much larger number of individual job elements. Thus, factor analyzing a set of measurements identifies quantitatively underlying factors which can be used to relate the original measures.

The principal-axis method. Numerous methods of performing a factor analysis are available for use; e.g., the square-root method, the maximum-likelihood method, the various centioid methods, and the principal-axis method. Some of the above methods have been deemed obsolete by the advent of the computer because they are approximations to better methods, and the rigorous calculations of the better methods are simplified by using computers.

Data from the physical testing technicians questionnaire were factor analyzed by the principal-azis method primarily for two reasons: (a) the availability of a standard computer program and (b) the inherent technical advantages of the principal-axis method over other methods. The technical advantages of the principal-axis method are: (a) each factor extracting the maximum amount of variance, (b) condensation of the correlation matrix into the smallest number of orthogonal factors, and (c) a mathematically unique (least squares) solution for a given table of correlations (Fruchter, 1954, p. 99). Also, Cureton (1968, pp. 3-4) relates that any method could lead to a Heywood case in which a communality is greater than unity. Thus, Cureton feels that initial factoring should be done by the principal-axis method with at most one

or two large iterations to insure that the number of factors retained has not been biased by the errors in the initial communality estimates.

Treatment of the data. In order to maintain a balance between the number of variables and the number of respondents, the entire sample as collected by Valentine (1971) was used for this factor analysis. Any effort to segregate portions of the sample would have served only to reduce the significance of the factor analysis. The 419 respondents were considered to be a sample of physical testing technicians in the plastics industry throughout the United States. The variables, or job elements, were considered to be exhaustive for those included in the job being studied. Even though it was the intent of this study to give results that could be generalized to all physical testing technicians in the plastics industry, the job elements were held to be a finite population.

Since a comprehensive understanding of factor analysis lies neither within the ability of the writer nor within the overall scope of this thesis, only an outline of the procedures used will be reported. Extensive discussions of factor analysis theory and application can be found in Fruchter (1954), Harman (1967), Thurstone (1947), Horst (1965), and Vernon (1971).

In order to fit the data to the factor analysis programs of Cureton (1969), it was necessary to reduce the number of variables to a maximum of 150. The method selected for this reduction was to actually factor analyze the data twice--once using the odd-numbered responses and once

using the even-numbered items from Valentine's (1971) questionnaire. By odd and even, the author refers to every other item in the order of appearance and not specifically odd or even according to Valentine's (1971) enumeration. The data cards used by Valentine for his analysis were also used for this work. All demographic or personal data were omitted from the factor analysis because the numerical values of the responses were not directly related to their actual worth, as was the case for all other responses. All of the items factor analyzed were job elements for physical testing technicians in the plastics industry. Pearson product-moment correlations of a given item in every questionnaire with all other odd- or even-numbered items were computed. With regard to missing data, each correlation was computed using the n available for the pair of variables in question. Then a principal-axis factor matrix was calculated for each of the 142-item intercorrelation matrices using the Prinax computer program devised by Cureton (1969) and located in The University of Tennessee Computer Center. The number of variables used for each calculation was reduced from a maximum of 143 to 142 to meet the program requirements. In each case, the very last item in the data set was omitted. These end products from the Prinax program contained 20 factors and are termed the final unrotated factor matrices, or simply the F-matrices.

Once the Prinax programs had been completed, data were extracted for a preliminary scree test to determine the number of variables to rotate.

After deciding to rotate seven factors for each data set, the varimax (orthogonal) and three promax (oblique) rotations were performed using the Promax computer program devised by Cureton (1969) and located in The University of Tennessee Computer Center.

The interpretations and naming of the factors from the final Promax factor matrices were performed independently by (1) a supervisor of a physical testing laboratory for plastics and a member of D-20 Committee of ASTM, (2) the supervisor of a plastics processing production operation, (3) Mr. Valentine, who was also a member of D-20, and (4) the author. Once these independent analyses were completed, the author consulted with the others to obtain final agreement on the names of the factors. The names given to each factor were then correlated for the two distinct data sets.

A preliminary, and only that, report which describes in part the computer programs just reported has been written by Durfee (1967).

CHAPTER IV

RESULTS

Demographic Information

Although the demographic variables from page 1 of the answer sheets were not included in the factor analysis, they are considered to be important enough for inclusion in this work. There were eight demographic variables used to describe the sample of respondents.

Age and sex. Of the 419 respondents, 11 percent were less than 25 years of age, 31 percent were between the ages of 25 and 34, 27 percent were between the ages of 35 and 44, and 31 percent were over 44 years of age.

The sample was predominantly male (90 percent) with only 10 percent female respondents. Two respondents left this item blank in the questionnaire.

Job title. The responses to this item exemplifed the difficulty of defining the job description and job title of physical testing technician. Of the 419 respondents, 56 percent indicated "technician", 25 percent indicated "supervisors", 1 percent indicated "trainee", and the remaining 18 percent failed to indicate any of the above titles.

Primary responsibility. With regard to primary responsibility, 47 percent indicated "research and development", 32 percent indicated "technical service", and 8 percent indicated "other".

Education. Formal education of the sample was divided roughly into thirds between "high school graduates or less", "some college attendance", and "a college degree".

Only 24 percent of the sample indicated any vocational training.

Experience. The group was considerably experienced with 42 percent indicating over 10 years' experience as a physical testing technician.

Job duties. Physical testing occupied 75 to 100 percent of the respondent's time in 47 percent of the sample. Only 17 percent indicated less than 25 percent of their time in these duties.

The Factors

Results of the analysis yielded seven factors for the odd-numbered items and seven factors for the even-numbered items. Condensed statements and means for the job elements which had loadings of at least 0.350 in the third promax matrix are given for each factor.

For the sake of convenience, names were devised for the factors based on the job elements which loaded highest. It should be remembered, however, that these labels are not fully indicative of the range of a given factor because they are subjective and based more on the elements with the highest loadings than those with lesser loadings.

Factor 1, odd-numbered responses. The first factor for the odd-numbered responses (see Table 2) has been termed "Mechanical Tests (A)". There appears to be strong emphasis on physical tests that measure the mechanical properties of plastic materials. Items loading above 0.500,

TABLE 2

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 1, ODD-NUMBERED RESPONSES; MECHANICAL TESTS (A)

Item No.	Question No.	Classification	Item	Loading	Means
69	2-80	Tests	Flexural Modulus of Elasticity	0.583	2.548
68	2-78	Tests	Falling Weight Impact Strength	0.559	1.957
65	2-72	Tests	Deflection Temperature Under Load	0.556	2.288
92	3-51	Tests	Tensile Heat Distortion Temperature	0.547	1.011
30	1-77	Tools and Equipment	Oxygen Bomb	0.537	0.463
97	3-61	Calculations	Strength of Materials	0.537	3.085
95	3-57	Tests	Volume Resistivity	0.533	1.198
93	3-53	Tests	Dissipation Factor	0.531	1.004
94	3-55	Tests	Arc Resistance	0.516	0.751
66	2-74	Tests	Tear Strength	0.509	2.639
64	2-70	Tests	APHA Color	0.486	0.517
89	3-45	Tests	Joint Strength (Pipe)	0.482	0.696
29	1-75	Tools and Equipment	Impact Machine	0.459	2.766
99	3-65	Calculations	Relative Viscosities, Shear Force	0.404	1.809

with the exception of "oxygen bomb", are tests specifically related to mechanical properties of plastic materials.

Factor 2, odd-numbered responses. The second factor (see Table 3) has been termed "Exoteric Functions". The emphasis in this factor is on items which are readily comprehensible and pertain to jobs other than the specific job of physical testing technician. The six items loading the heaviest on this factor ("consult with marketing personnel", "prepare material for technical publication", "maintain records of materials tested", "review work schedules and revise assignments", "one to two years college", and "technical nomenclature") could relate to jobs other than physical testing technician and all loaded above 0.631 on this factor. The only items which might be construed as relating specifically to the job of physical testing technicians are "maintain records of materials tested", and "a need for analytical ability"; but even these items are recognizable as not being related solely to the job of physical testing technician.

Factor 3, odd-numbered responses. The third factor (see Table 4) has been termed "Chemical Tests". There appears to be strong emphasis on physical tests for materials that are specifically related to chemical type testing. The fact that the item "quantitative analytical chemistry" has a high loading (0.430) is indicative of the items loading on this factor. With only five exceptions ("color reference system", "machine specimens", "blocking", "classify visual defects", and "particle

TABLE 3

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 2, ODD-NUMBERED RESPONSES; EXOTERIC FUNCTIONS

Item No.	Question No.	Classification	Item	Loading	Means
119	4-30	Supervision	Consult with Marketing Personnel	0.730	1.704
105	3-77	Clerical Duties	Prepare Material for Technical Publication	0.675	1.539
104	3-75	Clerical Duties	Maintain Records of Materials Tested	0.669	3.687
120	4-32	Supervision	Review Work Schedules and Revise Assignments	0.660	2.255
141	4-74	Knowledge, Education, Experience	One to Two Years College	0.647	1.959
138	4-68	Knowledge, Education, Experience	Technical Nomenclature	0.632	3.200
116	4-24	Supervision	Perform Calculations Alone	0.631	3.957
113	4-18	Supervision	Assume Compliance with Company Policy	0.615	3.577
128	4-48	Physical and Mental	A Need for Analytical Ability	0.614	3.291
121	4-34	Supervision	Act as a Working Leader	0.588	2.252
106	3-79	Clerical Duties	Prepare Verbal Reports for Meetings	0.576	1.727
122	4-36	Supervision	Evaluate the Performance of Others	0.572	1.832
137	4-66	Knowledge, Education, Experience	Electricity	0.561	1.988
135	4-62	Knowledge, Education, Experience	Physical Chemistry	0.548	2.021
133	4-58	Knowledge, Education, Experience	General Chemistry	0.521	2.613
136	4-64	Knowledge, Education, Experience	Mathematics	0.510	3.680
117	4-26	Supervision	Solve Problems on Own Initiative	0.504	3.830
118	4-28	Supervision	Consult with Chemists or Engineers	0.496	3.568
111	4-14	Responsibilities	Assist Others in Acquiring Information	0.471	3.656
124	4-40	Results of Errors	Can Result in Loss of Over $100,000	0.440	1.112

TABLE 3 (continued)

Item No.	Question No.	Classification	Item	Loading	Means
139	4-70	Knowledge, Education, Experience	Less Than High School Education	0.427	0.441
134	4-60	Knowledge, Education, Experience	Quantitative Analytical Chemistry	0.405	1.739
127	4-46	Physical and Mental	Work Involving Small Detail	0.404	3.050
115	4-22	Supervision	Am Closely Supervised	0.370	1.782
109	4-10	Responsibilities	Consider Limitations of Others	0.369	2.556
125	4-42	Results of Errors	Can Result in Loss Over $1000	0.355	2.405

TABLE 4

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 3, ODD-NUMBERED RESPONSES; CHEMICAL TESTS

Item No.	Question No.	Classification	Item	Loading	Means
34	2-10	Tests	Filtration	0.769	1.042
100	3-67	Calculations	Standard Deviations	0.757	2.582
33	2-08	Tests	Titrations	0.701	0.947
35	2-12	Tests	Compositions of Plastic Materials	0.667	1.739
23	1-63	Tools and Equipment	Pycnometer	0.564	1.176
27	1-71	Tools and Equipment	Color Reference System	0.528	1.202
98	3-63	Calculations	Percent Loss or Gain	0.523	3.045
28	1-73	Tools and Equipment	Gas Chromatograph	0.515	0.704
25	1-67	Tools and Equipment	Photometric Unit	0.502	1.054
39	2-20	Tests	Boiling Point	0.485	0.957
78	3-23	Tests	Pourability	0.461	0.711
62	2-66	Tests	Spectral Transmittance	0.441	0.859
134	4-60	Knowledge, Education, Experience	Quantitative Analytical Chemistry	0.430	1.739
31	1-79	Tools and Equipment	Sieves	0.429	1.269
80	3-27	Tests	Sag Flow	0.427	0.357
26	1-69	Tools and Equipment	Nessler Tubes	0.399	0.348
19	1-55	Sample Preparation	Machine Specimens	0.396	2.059
42	2-26	Tests	Blocking	0.392	0.923
63	2-68	Tests	Classify Visual Defects	0.364	1.840
38	2-18	Tests	Particle Size	0.350	1.389

size"), all items loading above 0.350 are chemical tests. Of the five exceptions, only "color reference system" loads greater than 0.396.

Factor 4, odd-numbered responses. The fourth factor (see Table 5) has been termed "Mechanical Tests (B)". All of the items loading above 0.350 on this factor are physical tests that measure mechanical properties of plastic materials. Several of the items ("creep and stress relaxation", "orientation release stress", "resistance to puncture propagation", "lap shear strength", and "film yield") are tests which have been developed primarily to test properties of unique interest for plastic materials.

Factor 5, odd-numbered responses. The fifth factor (see Table 6) has been termed "Esoteric, Nontechnical Functions". The aspects of the physical testing job that are described by this factor are requirements that only someone performing the physical testing function would fully understand. "Patience", "good memory for details of previous work", "work involving small detail", and "working in an office area" are all included in the "Physical and Mental Demands" classification of the questionnaire, and all load above 0.449. "Patience" is the only item loading above 0.500. The other remaining items loading above 0.350 are related to considerations and procedures required for the physical testing job.

Factor 6, odd-numbered responses. The sixth factor (see Table 7) has been termed "Plastic Materials". This factor is perhaps the easiest factor to define since every item loading above 0.350 was a plastic material.

TABLE 5

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 4, ODD-NUMBERED RESPONSES; MECHANICAL TESTS (B)

Item No.	Question No.	Classification	Item	Loading	Means
86	3-39	Tests	Creep and Stress Relaxation	0.560	1.307
87	3-41	Tests	Burst Pressure (Pipe or Container)	0.536	1.112
51	2-44	Tests	Water Immersion Stability	0.521	1.634
88	3-43	Tests	Orientation Release Stress	0.474	0.536
85	3-37	Tests	Resistance to Puncture Propagation	0.446	0.868
71	3-09	Tests	Lap Shear Strength	0.405	1.162
70	3-07	Tests	Film Yield	0.376	1.391

TABLE 6

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 5, ODD-NUMBERED RESPONSES; ESOTERIC, NONTECHNICAL FUNCTIONS

Item No.	Question No.	Classification	Item	Loading	Means
131	4-54	Physical and Mental	Patience	0.531	3.875
110	4-12	Responsibilities	Determine Work Procedures	0.488	3.248
114	4-20	Supervision	Have My Work Frequently Checked	0.474	2.217
107	4-06	Responsibilities	Consider Economy	0.472	3.119
129	4-50	Physical and Mental	Good Memory for Details Previous Work	0.455	3.861
127	4-46	Physical and Mental	Work Involving Small Detail	0.452	3.050
132	4-56	Physical and Mental	Working in an Office Area	0.449	2.651
111	4-14	Responsibilities	Assist Others in Acquiring Information	0.435	3.656
109	4-10	Responsibilities	Consider Limitations of Others	0.423	2.556
116	4-24	Supervision	Perform Calculations Alone	0.415	3.957
126	4-44	Results of Errors	Can Result Loss of Substantial Business	0.378	2.178
103	3-73	Clerical Duties	Be Proficient in Use of Lab Files	0.376	3.551

TABLE 7

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 6, ODD-NUMBERED RESPONSES; PLASTIC MATERIALS

Item No.	Question No.	Classification	Item	Loading	Means
11	1-39	Plastic Materials	Polyvinyl Chloride	0.621	2.334
5	1-27	Plastic Materials	Allyl Compounds	0.574	0.615
9	1-35	Plastic Materials	Polycarbonates.	0.536	1.152
6	1-29	Plastic Materials	Epoxies	0.533	1.415
8	1-33	Plastic Materials	Olefins (Polyethylene, etc.)	0.532	2.823
10	1-37	Plastic Materials	Polystyrene	0.491	1.747
4	1-25	Plastic Materials	Acetal	0.488	0.651
7	1-31	Plastic Materials	Melamines	0.471	0.627

Factor 7, odd-numbered responses. The seventh factor (see Table 8) has been termed "Intrinsic Properties Tests". The items loading on this factor are all characterized as relating to properties which plastic materials possess by their very nature or their particular form. The items ("pelletize", "extrusion rheometer", "prepare powder blends", "prepare laminates", and "peak exotherm") loading greater than 0.500 on this factor all relate to specific plastic processing operations and do not avail themselves to other operations or to all materials.

Factor 1, even-numbered responses. The first factor for the even-numbered responses (see Table 9) has been termed "Mechanical Tests (A)". Again, as in Factor 1, odd-numbered responses, there appears to be strong emphasis on physical tests that measure the mechanical properties of plastic materials. The only items not related to mechanical properties are "english and metric equivalents", "oxygen index", and "thermosetting plastics", all of which have loadings below 0.508.

Factor 2, even-numbered responses. The second factor (see Table 10) has been termed "Exoteric Functions". The emphasis in this factor is on items which are readily comprehensible and pertain to jobs other than the specific job of physical testing technician. The seven items loading the heaviest on this factor ("work with other groups", "engineering terminology", "assign duties to others", "make optimum use of time/ materials", "review new test methods", "recommend or grant promotions", and "check results of others") could relate to jobs other than physical testing technician, and all loaded above 0.561 on this factor. The only

TABLE 8

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 7, ODD-NUMBERED RESPONSES; INTRINSIC PROPERTY TESTS

Item No.	Question No.	Classification	Item	Loading	Means
15	1-47	Sample Preparation	Pelletize	0.599	0.627
24	1-65	Tools and Equipment	Extrusion Rheometer	0.586	1.288
12	1-41	Sample Preparation	Prepare Powder Blends	0.567	1.112
16	1-49	Sample Preparation	Prepare Laminates	0.563	0.832
81	3-29	Tests	Peak Exotherm	0.503	0.696
32	2-06	Tools and Equipment	Soxhlet Extractor	0.409	0.727
77	3-21	Tests	Coefficient of Friction	0.398	1.484
60	2-62	Tests	Optical Clarity	0.383	1.379
58	2-58	Tests	Refractive Index	0.376	0.842

TABLE 9

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 1, EVEN-NUMBERED RESPONSES; MECHANICAL TESTS (A)

Item No.	Question No.	Classification	Item	Loading	Means
69	3-06	Tests	Modulus of Elasticity	0.547	2.737
94	3-56	Tests	Insulation Resistance	0.545	1.112
65	2-73	Tests	Tensile Properties	0.544	3.615
95	3-58	Tests	Surface Resistivity	0.528	0.985
56	2-55	Tests	Water Extraction	0.521	0.995
93	3-54	Tests	Electrical Loss Factor	0.516	0.887
75	3-18	Tests	Vicat Softening Point	0.516	1.372
101	3-70	Calculations	English & Metric Equivalents	0.508	2.474
49	2-41	Tests	Accelerated Service Conditions	0.505	2.042
48	2-39	Tests	Smoke Density	0.505	0.835
91	3-50	Tests	Ignition Properties	0.492	1.193
19	1-56	Tools and Equipment	Analytical Balance	0.460	3.467
98	3-64	Calculations	Molecular Weights	0.433	1.011
47	2-37	Tests	Oxygen Index	0.426	1.083
51	2-45	Tests	Underground Stability	0.418	0.548
37	2-17	Tests	Dimensions and Tolerances	0.410	2.949
97	3-62	Calculations	Modulus Values	0.393	2.871
18	1-54	Sample Preparation	Condition to Specified Humidity	0.393	2.878
45	2-33	Tests	Warpage	0.367	1.792
29	1-76	Tools and Equipment	Testing Machine for Mechanical Properties	0.357	3.155
2	1-20	Plastic Materials	Thermosetting Plastics	0.355	2.054

TABLE 10

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 2, EVEN-NUMBERED RESPONSES; EXOTERIC FUNCTIONS

Item No.	Question No.	Classification	Item	Loading	Means
117	4-27	Supervision	Work With Other Groups	0.640	3.412
138	4-69	Knowledge, Education, Experience	Engineering Terminology	0.632	2.653
120	4-33	Supervision	Assign Duties to Others	0.611	2.233
110	4-13	Responsibilities	Make Optimum Use of Time and Materials	0.602	3.947
106	3-80	Clerical Duties	Review New Test Methods	0.601	2.723
122	4-37	Supervision	Recommend or Grant Promotions	0.594	1.202
121	4-35	Supervision	Check Results of Others	0.562	2.420
129	4-51	Physical and Mental	A High Degree of Dexterity	0.543	3.219
111	4-15	Responsibilities	Assume Responsibility for Results	0.538	4.062
109	4-11	Responsibilities	Meet Project Deadlines	0.516	3.482
123	4-39	Results of Errors	Are Highly Probably Because of Job Duties	0.511	1.665
119	4-31	Supervision	Must Demonstrate Leadership	0.500	2.871
128	4-49	Physical and Mental	A Need for Inventive Ability	0.497	3.176
107	4-07	Responsibilities	Consider Safety	0.490	4.303
118	4-29	Supervision	Consult with Production Personnel	0.487	2.088
124	4-41	Results of Errors	Can Result in Loss Over $10,000	0.484	1.727
132	4-57	Physical and Mental	Working in Well-Lighted Ventilated Area	0.482	4.045
125	4-43	Results of Errors	Can Result in Loss Over $100	0.479	2.780
126	4-45	Physical and Mental	Above Normal Visual Demand	0.455	2.832
105	3-78	Clerical Duties	Read Trade Publications	0.448	2.474
135	4-63	Knowledge, Education, Experience	Physics	0.440	2.386
133	4-59	Knowledge, Education, Experience	Organic Chemistry	0.440	2.109
136	4-65	Knowledge, Education, Experience	Algebra	0.432	2.954

TABLE 10 (continued)

Item No.	Question No.	Classification	Item	Loading	Means
134	4-61	Knowledge, Education, Experience	Qualitative Analytical Chemistry	0.418	1.708
131	4-55	Physical and Mental	Good Memory for Procedures	0.418	4.078
102	3-72	Clerical Duties	Maintain Laboratory Notebooks	0.406	3.536
112	4-17	Responsibilities	Work with Government Classified Information	0.394	0.880
113	4-19	Responsibilities	Recommend Changes to Supervision	0.383	2.954
116	4-27	Supervision	Use Much Personal Judgment	0.377	3.897
137	4-67	Knowledge, Education, Experience	Statistics	0.476	2.310
130	4-53	Physical and Mental	Physical Strength	0.372	2.076
103	3-74	Clerical Duties	Keep Time, Production or Clerical Records	0.364	2.701

items which might be construed as relating specifically to the job of physical testing technicians are "review new test methods", "good memory for procedures", and "maintain laboratory notebooks", but even these items are recognizable as not being related solely to the job of physical testing technician.

Factor 3, even-numbered responses. The third factor (see Table 11) has been termed "Chemical Tests". Again, as in the items for Factor 3, odd-numbered responses, there appears to be strong emphasis on tests that are chemical in nature. The fact that the items "qualitative analytical chemistry" and "organic chemistry" load at 0.464 and 0.428, respectively, again demonstrates the nature of the items loading on this factor. The three items loading heaviest on this factor ("acidity and basicity", "normalities of solutions", and "chemical resistance" are purely chemical tests, and all load greater than 0.579 on this factor.

Factor 4, even-numbered responses. The fourth factor (see Table 12) has been termed "Plastic Materials". The four items with the heaviest loadings on this factor ("nylon", "cellulosics", "fluorocarbons", and "acrylates and methacrylates") were all plastic materials, and all loaded 0.399 or greater. Of the remaining five items which loaded above 0.350, two items ("polyesters" and "laminates") were also plastic materials.

Factor 5, even-numbered responses. The fifth factor (see Table 13) has been termed "Esoteric, Nontechnical Functions". Again the aspects

TABLE 11

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 3, EVEN-NUMBERED RESPONSES; CHEMICAL TESTS

Item No.	Question No.	Classification	Item	Loading	Means
33	2-09	Tests	Acidity and Basicity	0.660	0.945
34	2-11	Tests	Normalities of Solutions	0.657	0.852
43	2-29	Tests	Chemical Resistance	0.580	1.801
32	2-07	Tools and Equipment	Accelerated Weathering Equipment	0.533	1.715
44	2-31	Tests	Environmental Stress Cracking	0.531	2.011
35	2-13	Tests	Refluxing	0.526	0.930
58	2-59	Tests	Haze	0.526	1.482
27	1-72	Tools and Equipment	Infrared Analyzer	0.507	0.914
26	1-70	Tools and Equipment	Spectrophotometer	0.501	1.071
39	2-21	Tests	Ash Content	0.482	1.300
134	4-61	Knowledge, Education, Experience	Qualitative Analytical Chemistry	0.464	1.708
13	1-44	Sample Preparation	Apply Plastic Coatings	0.455	0.782
28	1-74	Tools and Equipment	Potentiometric Titration	0.451	0.436
31	1-80	Tools and Equipment	Vacuum System	0.430	1.742
14	1-46	Sample Preparation	Roto or Slush Moldings	0.429	0.207
133	4-59	Knowledge, Education, Experience	Organic Chemistry	0.428	2.109
80	3-28	Tests	Gel Time	0.417	0.947
38	2-19	Tests	Freezing Point	0.413	0.849
57	2-57	Tests	Low Temperature Flexibility	0.412	1.770
81	3-30	Tests	Fusion by Torque Rheometer	0.402	0.536
59	2-61	Tests	Turbidity	0.399	0.494
78	3-24	Tests	Relative Viscosity	0.384	1.455
36	2-15	Tests	Statistical Sampling	0.380	1.780
64	2-71	Tests	Deformation Under Load	0.375	2.465
53	2-49	Tests	Thermal Oxidation	0.371	0.887

TABLE 12

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 4, EVEN-NUMBERED RESPONSES; PLASTIC MATERIALS

Item No.	Question No.	Classification	Item	Loading	Means
7	1-32	Plastic Materials	Nylon	0.547	1.525
5	1-28	Plastic Materials	Cellulosics	0.519	0.887
6	1-30	Plastic Materials	Fluorocarbons	0.450	0.983
4	1-26	Plastic Materials	Acrylates and Methacrylates	0.399	1.305
73	3-14	Tests	Flexural Stress (Fatigue)	0.399	1.577
9	1-36	Plastic Materials	Polyesters	0.391	1.923
71	3-10	Tests	Column Crush Properties (Containers)	0.387	0.589
74	3-16	Tests	Durometer Hardness	0.378	2.047
2	1-22	Plastic Materials	Laminates	0.378	1.899

TABLE 13

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 5, EVEN-NUMBERED RESPONSES; ESTOTERIC, NONTECHNICAL FUNCTIONS

Item No.	Question No.	Classification	Item	Loading	Means
127	4-47	Physical and Mental	Long Periods of Concentration	0.482	2.868
104	3-76	Clerical Duties	Conduct Studies and Write Reports	0.481	3.124
114	4-21	Supervision	Solve Problems by Consulting Others	0.431	3.038
130	4-53	Physical and Mental	Physical Strength	0.420	2.076
129	4-51	Physical and Mental	A High Degree of Dexterity	0.417	3.219
98	3-64	Calculations	Molecular Weights	0.400	1.011
131	4-55	Physical and Mental	Good Memory for Procedures	0.385	4.078
111	4-15	Responsibilities	Assume Responsibility for Results	0.369	4.062
103	3-74	Clerical Duties	Keep Time, Production, or Clerical Records	0.369	2.701
115	4-23	Supervision	Work Independently	0.357	3.615
116	4-25	Supervision	Use Much Personal Judgment	0.356	3.897

of the physical testing job that are described by this factor are requirements that only someone performing the physical testing function would fully understand. "Long periods of concentration", "physical strength", "a high degree of dexterity", and "good memory for procedures" are all included in the "Physical and Mental Demands" classification of the questionnaire, and all load above 0.385 on this factor. The other remaining items loading above 0.350 are related to communication considerations and procedures required for the physical testing job.

Factor 6, even-numbered responses. The sixth factor (see Table 14) has been termed "Mechanical Tests (B)". The three items ("compressive properties", "flattening pressure for pipe", and "brittleness temperature") loading above 0.564 on this factor are physical tests that measure mechanical properties of plastic materials. Other than the item "work with government-classified information", the items loading on this factor relate to testing properties of unique interest for plastic materials.

Factor 7, even-numbered responses. The seventh factor (see Table 15) has been termed "Intrinsic Properties Tests". The nine items loading heaviest (greater than 0.459) on this factor are all physical tests which determine properties which plastics materials possess by their very nature or their particular form. The underlying scheme for items loading on this factor is that the tests are measures of properties that a plastic material may or may not possess, depending primarily on the final processed form.

TABLE 14

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 6, EVEN-NUMBERED RESPONSES; MECHANICAL TESTS (B)

Item No.	Question No.	Classification	Item	Loading	Means
89	3-46	Tests	Compressive Properties	0.696	1.732
87	3-42	Tests	Flattening Pressure (Pipe)	0.607	0.739
90	3-48	Tests	Brittleness Temperature	0.565	1.577
96	3-60	Calculations	Thermal Conductivity	0.450	0.818
22	1-62	Tools and Equipment	Hydrometer	0.380	1.317
112	4-17	Responsibilities	Work with Government Classified Information	0.359	0.880

TABLE 15

FACTOR LOADINGS AND MEANS FOR ITEMS ON FACTOR 7, EVEN-NUMBERED RESPONSES; INTRINSIC PROPERTY TESTS

Item No.	Question No.	Classification	Item	Loading	Means
70	3-08	Tests	Delamination Strength	0.607	1.410
83	3-34	Tests	Void Content (Solids)	0.602	0.739
61	2-65	Tests	Crocking	0.574	0.389
60	2-63	Tests	Luminous Transmittance	0.550	1.085
77	3-22	Tests	Flow Rate	0.538	1.756
85	3-38	Tests	Resistance to Puncture Propagation	0.531	1.288
42	2-27	Tests	Moisture Content	0.494	1.868
72	3-12	Tests	Orientation Stress Release	0.480	0.677
54	2-51	Tests	Stain Resistance	0.460	0.988
8	1-34	Plastic Materials	Phenolics	0.458	1.023
52	2-47	Tests	Gas Transmission	0.438	1.076
88	3-44	Tests	Hydrostatic Compressive Strength	0.400	0.496
66	2-75	Tests	Izod Impact Strength	0.385	2.474
79	3-26	Tests	Dry Flow	0.384	0.544
25	1-68	Tools and Equipment	Refractometer	0.380	0.658
67	2-77	Tests	Free Falling Dart Impact Strength	0.377	1.711
62	2-67	Tests	Suspended Matter	0.355	0.577

The Correlation of Factors

The magnitude of the physical testing technician questionnaire made it necessary to split the data into two sets, odd-numbered responses and even-numbered responses, and then extract factors for each set.

Factor 1. This factor was named the same for both the odd-numbered and even-numbered responses. A check of the items in Tables 2, page 27, and 9, page 38, will show the similarities.

Factor 2. This factor was also named the same for both sets of data, and a check of Tables 3, page 29, and 10, page 39, will show the reason.

Factor 3. This factor was named the same for both data sets. A check of Tables 4, page 31, and 11, page 42, will reveal the similar nature of items for both data sets.

Factor 4. This factor was named "Mechanical Tests (B)" for the odd-numbered responses and correlated with Factor 6 for the even-numbered responses. A check of Tables 5, page 33, and 14, page 46, will show the similarity of items loading on each factor.

Factor 5. This factor was named the same for both data sets. A check of Tables 6, page 34, and 13, page 44, will show the similarity of items for both data sets.

Factor 6. This factor was named "Plastic Materials" for the odd-numbered responses and correlates well with Factor 4 from the

even-numbered responses as a look at Tables 7, page 35, and 12, page 43, will indicate.

Factor 7. This factor was named the same for both data sets. A check of Tables 8, page 37, and 15, page 47, will show the similarity of items for both data sets.

CHAPTER V

DISCUSSION

Determination of the Number of Factors

Since the problem of how to best estimate the communalities was handled by the Prinax computer program, efforts were directed to the difficult task of deciding the number of significant factors. According to Cureton (1968, p. 19),

> There appears to be no one method for determining the number of factors which can be rotated meaningfully. Following Tryon, I shall term this the number of salient factors. Even if we had an exact test of statistical significance, and an agreed upon rationale for selecting an α - level, the number of salient factors would not necessarily be the number of significant factors. With very large N, it might be less: I have seen significant factors (N=1000) with no loading greater than 0.20. With small N, it might be more; there is a crude analogy here to the case in simple analysis of variance with many categories of one class, where the F-test shows insignificance but a multiple-comparison test shows high significance for one category. An insignificant factor can sometimes determine a doublet or triplet of quite high significance and interpretability.

The Prinax computer program included the Bargmann test of significance but was not used in this work. The method of determination used in this study, and perhaps the best test for the number of salient factors, is the scree test (Cattell, 1966). Eigenvalues, which are the sums of squares of each column in the F-matrix were listed in order of magnitude along with a column of differences between each successive eigenvalue. Under the best of conditions, these eigenvalue differences will become progressively smaller until there is a reversal, e.g., a larger eigenvalue

difference occurs, which is followed by the remaining differences being smaller in magnitude. The number of factors whould be chosen such that the cumulative sum of the eigenvalues is reasonably close to 100 percent of trace, where trace is defined as the sum of the communality estimates. The reversal usually occurs at approximately 100 percent of trace.

Tables 16 and 17 show the eigenvalues for 20 factors for both the odd-numbered and the even-numbered responses. The data were not totally clear, but they did permit the judgment that the number of salient factors for each data set was seven. Looking at the eigenvalue differences for the odd-numbered responses, the first and very obvious reversal occurred at Factor 7. For the even-numbered responses, the first reversal occurred at Factor 5 but was not so obvious as the reversal at Factor 7 for the odd-numbered responses. The eigenvalue difference for Factor 6 of the even-numbered responses was significantly greater than the differences for the factors beyond Factor 7. For the odd-numbered responses, a maximum of only 71.5 percent of the variance was accounted for at seven factors; for the even-numbered responses, a maximum of only 74.3 percent of the variance was accounted for at seven factors. Being mindful of these shortcomings of the factor analysis (the reversal in eigenvalue differences should occur at 100 percent of trace), it was decided to rotate seven factors.

The percent of variance accounted for by each factor for the odd-numbered responses was 34.8 percent (Factor 1), 10.8 (2), 7.7 (3), 5.7 (4), 4.7 (5), 4.1 (6), and 3.8 (7). The percent of variance accounted for by each factor for the even-numbered responses was 35.6 (Factor 1), 11.5 (2), 8.4 (3), 5.8 (4), 5.0 (5), 4.0 (6) and 3.9 (7).

TABLE 16

EIGENVALUES, DIFFERENCES AND PERCENT OF VARIANCE
FOR 20 FACTORS, ODD-NUMBERED RESPONSES

Factor	Eigenvalue	Eigenvalue[a] Difference	Percent Variance
1	26.891		34.773
		18.600	
2	8.290		45.493
		2.365	
3	5.926		53.115
		1.554	
4	4.372		58.809
		0.727	
5	3.645		63.522
		0.483	
6	3.162		67.611
		0.158	
7	3.004		71.495
		0.281	
8	2.723		75.016
		0.316	
9	2.407		78.128
		0.216	
10	2.190		80.961
		0.307	
11	1.883		83.396
		0.117	
12	1.776		85.679
		0.135	
13	1.631		87.788
		0.084	
14	1.547		89.788
		0.157	
15	1.390		91.585
		0.063	
16	1.327		93.301
		0.187	
17	1.141		94.776
		0.039	
18	1.101		96.200
		0.060	
19	1.042		97.547
		0.048	
20	0.994		98.832

[a]Eigenvalues and eigenvalue differences were rounded separately. Consequently, the reported differences may vary from the differences between the reported eigenvalues by ± 0.001.

TABLE 17

EIGENVALUES, DIFFERENCES, AND PERCENT OF VARIANCE
FOR 20 FACTORS, EVEN-NUMBERED RESPONSES

Factor	Eigenvalue	Eigenvalue[a] Difference	Percent Variance
1	27.292	18.498	35.632
2	8.793	2.359	47.113
3	6.434	2.000	55.514
4	4.434	0.576	61.303
5	3.858	0.761	66.341
6	3.097	0.109	70.385
7	2.988	0.253	74.286
8	2.735	0.410	77.857
9	2.325	0.451	80.892
10	1.874	0.178	83.339
11	1.696	0.139	85.553
12	1.557	0.146	87.586
13	1.411	0.033	89.427
14	1.377	0.119	91.225
15	1.258	0.107	92.868
16	1.151	0.034	94.372
17	1.118	0.059	95.831
18	1.058	0.057	97.213
19	1.001	0.049	98.520
20	0.952		99.762

[a]Eigenvalues and eigenvalue differences were rounded separately. Consequently, the reported differences may vary from the differences between the reported eigenvalues by ± 0.001.

Selection of the Factor Loading Criterion

The determination of which job elements would be included in Tables 2 through 15 (see pages 27, 39-31, 33-35, 37-40, 42-44, 46, 47) taken from the promax matrices and, therefore, upon which the interpretation of the factors would depend, was arbitrary. The objective in setting a criterion level is to include all items of importance to naming each factor.

Historically, items whose loadings are higher than 0.200 have been included; but for the present study, such a criterion would have resulted in too many items having to be considered. For instance, Factors 1 and 2 for the odd-numbered responses would have contained, respectively, 34 and 38 elements. For this reason, and because the higher a factor loading, the more meaningful, the criterion level was established at 0.350.

General Comment on the Sample

Careful consideration of the information gathered in an effort to categorize the sample revealed that the sample was actually much the same as suspected by the author. Of the eight categorizations chosen for sample characterization, only "experience" and "education" warrant discussion here. It was somewhat surprising that 30 percent of the respondents claimed a technical college degree and the 42 percent of the respondents had over 10 years experience.

With respect to job title, the variation in responses could be understood due to the difficulty encountered in finding a suitable

definition. This category appears to lend itself to a more in-depth analysis of the job title since 18 percent of the respondents checked "other", rather than one of the three titles listed.

With respect to vocational training, the fact that 76 percent of the respondents indicated they had received no training is strong justification for the establishment of a training program for physical testing technicians in the plastics industry.

The percentage (36.0) of respondents who reported spending 50 percent or less of their time with work directly related to physical testing seems reasonable, especially since 25 percent of the sample were supervisors and 42 percent had more than 10 years' experience. It would be expected to find the supervisors or the older more experienced technicians spending a great deal of time training others or consulting with persons not directly involved with physical testing.

Comparison with Valentine's Findings

Due to the method of analysis and more importantly to the possible inclusion of several jobs within the survey, Valentine points out the need for a more detailed analysis of the data collected. Specific mention is made of the large standard deviations and the clustering of responses toward either the high end or the low end of the response scale (Valentine, 1971, p. 41).

Throughout Valentine's study, the basic frame of reference for viewing job elemnts was the 11 questionnaire categories (see Table 1, page 18). In an effort to integrate this study with Valentine's, the

degree to which the two sets of seven factors were aligned with the categories of the questionnaire and the degree to which the two studies agreed on the importance of items was investigated.

Factor 1, Mechanical Tests (A). This factor was the same for both the even-numbered and the odd-numbered responses and derived its name from the fact that the majority of the items were mechanical tests from the "Tests" classification of the questionnaire. Valentine reported that "tensile properties" ranked first with a mean of 3.615, and this item loaded 0.544 on Factor 1, even-numbered responses, further indicating the importance of this item. Valentine reported no other item having a mean above 3.00 and related the low means for "Tests" items, in general, to specialties in the field. The items from the "Tests" classification which loaded significantly on Factor 1, Mechanical Tests (A), ranged from "tensile properties" with a mean of 3.615 to "APHA Color" with a mean of 0.517.

Factor 2, Exoteric Functions. This factor was the same for both the even-numbered and the odd-numbered responses and derived its name from the fact that the items loading on this factor are readily comprehensible as requirements for a job, not particularly the job of physical testing technician. That the items loading on this factor have, generally, high means was not unexpected, nor was the fact that items loading on this factor represented six ("Supervision", "Knowledge, Education and Experience", "Responsibilities", "Clerical Duties", "Physical and Mental Demands", and "Results of Errors") of the 11 classifications Valentine

used in his questionnaire thought to be unusual. Items loading on this factor ranged from "consider safety" with a mean of 4.303 to "less than high school education" with a mean of only 0.441. It is interesting to note that from the 10 items loading the heaviest for the even- and odd-numbered data sets (total of 20 items), only seven items were specifically chosen by Valentine for comment ("work with other groups", "a high degree of dexterity", "assume responsibility for results", "maintain records of materials tested", "technical nomenclature", "perform calculations alone", and "a need for analytical ability").

Factor 3, Chemical Tests. This factor was the same for both the even-numbered and the odd-numbered responses and derived its name from the fact that the majority of the items were chemical tests from the "Tests" classification of the questionnaire. The items from the questionnaire were apparently treated as a dichotomy rather than a continuum, and the tests loading on this factor ranged from "percent loss or gain" with a mean of 3.045 to "roto--or sluch--moldings" with a mean of 0.207. Since only "standard deviations" (mean = 2.582) and "percent loss or gain" (mean = 3.045) had means greater than 2.5, and this factor was considered to be third in importance, there does appear to be considerable disagreement with Valentine's eventual conclusions.

Factor 4, Mechanical Tests (B). While this was the name given to Factor 4, odd-numbered responses, it was seen to correlate well with Factor 6, even-numbered responses; and the two will be combined for comparison to Valentine's findings. This factor derived its name from

the fact that the majority of the items loading on the factor were mechanical tests from the "Tests" classification of the questionnaire, particularly the case for the odd-numbered responses. To differentiate between Factor 1, Mechanical Tests (A), and this factor is difficult, but the items loading on Mechanical Tests (B) are perhaps less commonplace than the majority of tests loading on Factor 1. The tests loading on this factor ranged from "compressive properties" with a mean of 1.732 to "orientation stress release" with a mean of 0.536.

Factor 5, Exoteric, Nontechnical Functions. This factor was the same for both the even- and the odd-numbered responses and derived its name from the fact that while the items were similar in nature to those loading on Factor 2, only someone experienced in physical testing work would fully appreciate the significance of these items. The similarily between Factor 2 and this factor can be noted by realizing that the items loading on this factor represented the same six classifications ("Supervision", "Knowledge, Education and Experience", "Responsibilities", "Clerical Duties", Physical and Mental Demands", and "Results of Errors") as the items loading on Factor 2. Items loading on this factor ranged from "good memory for procedures" with a mean of 4.078 to "molecular weights" with a mean of 1.011. Of particular note for this factor is the fact that "perform calculations alone" had the highest mean (3.957) of the items in the classification "Supervision", yet there were 10 items ranked higher according to their loading on Factor 5, odd-numbered responses.

Factor 6, Plastic Materials. While this was the name given to Factor 6, odd-numbered responses, it was seen to correlate well with Factor 4, even-numbered responses; and the two will be combined for comparison to Valentine's findings. This factor derived its name from the fact that the majority of the items loading on the factor were plastic materials. The two items from the "Plastic Materials" classification with the highest means ("thermoplastics" - 3.365 and "experiemental materials" - 3.322) did not load on this factor. A reasonable explanation for this occurrence is the fact that "thermoplastics" and "experimental materials" are general items; whereas, the items loading on Factor 6 are very explicit items.

Factor 7, Intrinsic Property Tests. This factor was the same for both the even- and the odd-numbered responses and derived its name from the fact that the majority of the items loading on this factor involved properties of materials that were peculiar to the particular form of the material. The items generally related to properties that a material must possess before the items were applicable. This was essentially the fourth factor extracted from the "Tests" classification of the questionnaire, and this factor differs from Factors 1, 3, and 4 as indicated previously; i.e., the properties tested are peculiar to the particular form of the material. The tests loading on Factor 7 ranged from "Izod impace strength" with a mean of 2.474 to "crocking" with a mean of 0.389.

Summary. To summarize the degree to which Valentine's organization is congruent with the factors obtained:

1. Plastic Materials is substantially the same as "Factor 6, Plastic Materials".
2. Sample Preparation involves items in the domains "Factor 1, Mechanical Testing (A)", "Factor 3, Chemical Testing", "Factor 4, Mechanical Testing (B)", and "Factor 7, Intrinsic Property Tests".
3. Tools and Equipment also involves items in the domains of "Factor 1, Mechanical Testing (A)", "Factor 3, Chemical Testing", "Factor 4, Mechanical Testing (B)", and "Factor 7, Intrinsic Property Tests".
4. Tests involves items in the domains of "Factor 1, Mechanical Testing (A)", "Factor 3, Chemical Testing", "Factor 4, Mechanical Testing (B)", and "Factor 7, Intrinsic Property Tests".
5. Calculations involves items in the domains of "Factor 1, Mechanical Testing (A)", "Factor 3, Chemical Testing", and "Factor 4, Mechanical Testing (B)".
6. Clerical Duties involves items in the domains of "Factor 2, Exoteric Functions" and "Factor 5, Esoteric, Nontechnical Functions".
7. Responsibilities involves items in the domains "Factor 2, Exoteric Functions" and "Factor 5, Esoteric, Nontechnical Functions".
8. Supervision involves items in the domains of "Factor 2, Exoteric Functions" and "Factor 5, Esoteric, Nontechnical Functions".

9. Results of Errors involves items in the domains of "Factor 2, Exoteric Functions" and "Factor 5, Esoteric, Nontechnical Functions".

10. Physical and Mental Demands involves items in the domains of "Factor 2, Exoteric Functions" and "Factor 5, Esoteric, Nontechnical Functions".

11. Knowledge, Education and Experience involves items in the domains of "Factor 2, Exoteric Functions", "Factor 3, Chemical Tests", and "Factor 5, Esoteric, Nontechnical Functions".

The results of the factor analysis suggest that items used in future questionnaires dealing with physical testing technicians in the plastics industry should be grouped into classifications much differently than they were in the present case. The primary benefit to be gained from this regrouping would be the potential reduction in misinterpretation by respondents resulting from the current format.

The results of performing the factor analysis for the odd-numbered responses and then repeating for the even-numbered responses also have significance in regard to future questionnaires dealing with physical testing technicians in the plastics industry. The correlation of the two distinct data sets would seem to imply that one data set was of little importance in the study. For this reason, it seems appropriate that not only should the items be regrouped for future questionnaires but that consideration be given to deleting approximately one-half of the items in the current questionnaire.

In terms of the item means, Valentine's study concluded that the highest importance was given to items grouped in the "Physical and Mental Demands" classification with an overall mean of 3.328. Also the classification "Tests" had the lowest overall mean (1.327); but this result was rationalized by claiming specialties among the tests for different technicians. The items loading above 0.350 on the factors in the current study were not necessarily the items having the highest means. Many items loaded above 0.350 on none of the factors, yet they must be considered important by virtue of their means. Those with a mean of 2.50 or more can be seen in Table 18.

With regard to the relative importance of the items making up the factors, the averages of the means of the items which had loadings of 0.350 or above were computed for each factor. This information is in Table 19.

Implication of Results for Training

Since persons completing the ORAU physical testing technician training project are hired by various companies, each of which requires capabilities relating primarily to a specific plastic or family of plastics, there is a premium on giving trainees a solid background in fundamentals that are necessary regardless of the plastics of interest to the particular company. The specific requirements of the individual companies cannot be included in a general-purpose training program and must be learned on the job. Specific requirements of individual companies change nearly as rapidly as the realm of the new plastics with

TABLE 18

ITEMS WITH MEANS OVER 2.50 WHICH LOADED ABOVE 0.350 ON NONE OF THE FACTORS

Questionnaire Number	Item	Mean
4-08	Consider quality	4.357
4-52	A high degree of accuracy	4.248
1-58	Oven	3.575
3-66	Arithmetic means (averages)	3.389
1-19	Thermoplastics	3.365
1-23	Experimental materials	3.322
1-53	Condition to a specified temperature	3.298
4-79	At least two years experience	3.236
4-38	Assist in training new personnel	2.995
4-71	High school education	2.766
2-79	Flexural strength	2.744
1-60	Constant temperature bath	2.687

TABLE 19

MEANS OF THE ITEM MEANS FOR EACH FACTOR

Factor	Factor Name	Mean of the Item Means
Odd-numbered responses		
5	Esoteric, Nontechnical Functions	3.160
2	Exoteric Functions	2.516
1	Mechanical Tests (A)	1.624
6	Plastic Materials	1.421
3	Chemical Tests	1.297
4	Mechanical Tests (B)	1.144
7	Intrinsic Property Tests	0.999
Even-numbered responses		
5	Esoteric, Nontechnical Functions	3.063
2	Exoteric Functions	2.788
1	Mechanical Tests (A)	1.907
4	Plastic Materials	1.415
3	Chemical Tests	1.248
6	Mechanical Tests (B)	1.177
7	Intrinsic Property Tests	1.103

which they are concerned which would make their inclusion in a training program a continuous updating procedure.

Factor analysis enables the investigator to generalize the job requirements by identifying underlying domains. The problem of generalizing factor analysis results lies in the representation of the sample. The primary concerns as to the nature and thoroughness of the sample are adequate representation of companies in the plastics industry and the relative positions of the respondents. Although no guarantees exist, it can be argued that the physical testing technician sample is reasonably representative and that trainees who attain competence in the indicated areas of importance will be more valuable to their employers than employees not so trained.

The agreement in the factor names for the odd-numbered responses and those for the even-numbered responses would indicate the validity of the factors. Final assessment of the factors must remain for experimental evaluation.

Statistical versus absolute importance. In the discussion of the results and the implications for training, two kinds of importance must be differentiated. A factor loading represents the statistical importance; it is simply the correlation between an item and the factor on which that item loads. Though the factor analysis does not reveal the absolute importance of the items, it may be viewed as a curriculum outline and nothing more.

The mean of an item is its measure of absolute importance and does not concern the factor loading of the item. Items having high means, regardless of factor loadings, are intrinsically important for training. Items having low means, again regardless of factor loadings, are not important except as definers of the meanings of the factors.

In summary, the importance of factor analysis in this study is to organize the underlying domains of the job of physical testing technicians in the plastics industry. The factor loadings are useful in determining the identity of these domains. Given the identity of the underlying domains, the relative importance of individual items can be ascertained by the means.

Recommendations. It is suggested that firms involved or interested in training physical testing technicians undertake the following:

1. The organization of any existing training program should be compared with that suggested by the factor analytic results. Furthermore, the emphasis placed on topics within a given content area should be compared with the important questionnaire items, as revealed by their means, which relate to that area.
2. Assuming that differences in organization do exist, the results of the present study should be incorporated into the training program.
3. Over a suitable period of time, a follow-up study should be completed comparing the new training program to the earlier

one based on graduate achievement. The importance of empirical results which would support this factor analytic study cannot be overemphasized.

4. The application of the present results to such areas as performance evaluation, wage and salary administration, and selection might be undertaken by some interested party.
5. In view of the rapidly changing plastics industry, it is recommended that any further administration of the present questionnaire for purposes of updating be done by elimination of approximately one-half of the existing items.

Although the above recommendations have been directed explicitly to ORAU and ASTM, it is felt that the results of this factor analysis are also applicable to others. The results should be of some benefit to the numerous vocational and trade schools throughout the country which may teach physical testing technician skills. Also companies which train their own physical testing technicians should derive benefit from this study. In all of the above cases, not only should the findings themselves be of importance, but the adaptability of the methodology to other occupational areas should be considered.

CHAPTER VI

SUMMARY AND CONCLUSION

A questionnaire containing 286 job elements was completed by 419 physical testing technicians and supervisors representing 101 companies located throughout the United States and Canada. The data were analyzed in order to determine what the content and organization should be for a training program applicable to physical testing technicians in the plastics industry. The purpose of a training program is to teach fundamental skills and traits such that the graduates will be qualified and capable of working in an industrial environment.

For adaptation to computer programming, the 286 job elements were divided into two distinct data sets prior to factor analysis by including alternate responses in each data set. Pearson product-moment correlations of a given item in every questionnaire with all remaining items in the particular data set were computed for 284 job elements. Less than the total number of questionnaire items were utilized in order to meet the computer programming requirements. The principal-axis method of factor analysis was applied to the two--142 by 142 intercorrelation matrices using estimated communalities. The scree test, supplemented by comparisons of factor loadings, was used to determine the number of salient factors.

Seven factors accounted for approximately 74 percent of the variance in the case of the odd-numbered responses and 72 percent in the case of

the even-numbered responses. The seven factors were the same for each distinct data set; and except for the relative importance of Factors 4 and 6, the ranking order of importance of each factor in a set was the same. Based on items whose factor loadings exceeded 0.350, the following descriptive labels were assigned:

1. Mechanical Tests (A)
2. Exoteric Functions
3. Chemical Tests
4. Mechanical Tests (B)
5. Esoteric, Nontechnical Functions
6. Plastic Materials
7. Intrinsic Property Tests

Domains represented by the factors were contrasted with the organization of the current questionnaire. It was learned, that in several instances, the factors were not in good general agreement with the questionnaire classifications. A distinction was made between statistical importance, as revealed by factor loadings, and absolute importance, as revealed by item means. An effort was made to cite the practical importance of the correlation of factors for the two distinct data sets, the odd-numbered responses, and the even-numbered responses. The utility of the results with respect to training was discussed, and recommendations were made concerning their implementation.

The conclusion is that, within the confines of the sample, the seven factors represent the most important general functions of the job of physical testing technician in the plastics industry. When applying

the results to the development of a training program or the improvement of an existing training program, the factors may be viewed as a curriculum outline with the job elements having high means indicative of specific course content.

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APPENDIXES

APPENDIX A

TABLE 20

VARIMAX MATRIX, ODD-NUMBERED RESPONSES

Seq.	1		2		3		4		5		6		7	
1	69	.689	119	.777	100	.797	86	.597	131	.524	11	.658	24	.615
2	68	.674	120	.744	34	.793	87	.564	129	.475	5	.588	15	.609
3	65	.657	105	.733	33	.759	51	.559	114	.465	8	.585	16	.607
4	97	.656	141	.721	35	.742	88	.507	110	.457	9	.582	12	.601
5	66	.619	104	.716	23	.669	85	.492	107	.452	6	.574	81	.537
6	95	.600	138	.679	27	.618	71	.454	132	.447	10	.528	32	.465
7	92	.599	122	.669	98	.604	70	.424	127	.423	4	.501	77	.453
8	89	.593	128	.660	25	.588	84	.387	109	.399	7	.481	60	.442
9	64	.588	121	.658	78	.584	45	.381	126	.398	2	.388	58	.435
10	30	.584	113	.647	28	.573	79	.377	130	.379	1	.387	75	.411
11	93	.579	116	.634	39	.564	73	.370	19	.377	61	.371	54	.385
12	94	.556	106	.634	62	.538	41	.370	111	.372	48	.360	17	.382
13	29	.545	137	.633	42	.518	52	.367	103	.362	32	.314	90	.378
14	74	.490	135	.588	80	.512	72	.366	20	.334	96	.305	67	.358
15	99	.479	133	.572	31	.508	82	.364	18	.324	3	.297	72	.349
16	18	.467	118	.549	134	.500	89	.360	102	.323	84	.295	14	.344
17	90	.460	136	.543	26	.492	83	.354	116	.320	50	.290	50	.342
18	73	.457	117	.541	56	.483	37	.348	97	.309	47	.264	57	.325
19	45	.453	139	.491	63	.469	50	.334	99	.300	13	.256	56	.318
20	75	.427	124	.468	22	.467	54	.333	115	.282	91	.248	53	.318
21	47	.424	111	.455	38	.464	57	.333	117	.280	56	.245	44	.305
22	101	.418	134	.447	133	.439	64	.324	17	.259	55	.228	78	.297
23	84	.413	127	.401	19	.429	49	.322	65	.238	45	.228	61	.289
24	46	.404	109	.378	40	.425	55	.321	21	.233	59	.225	47	.283
25	37	.394	108	.376	13	.421	44	.296	113	.232	89	.219	40	.274
26	67	.377	115	.352	76	.411	76	.296	57	.229	49	.218	93	.249
27	82	.368	125	.349	21	.391	80	.294	124	.228	46	.211	92	.248
28	85	.363	112	.338	79	.391	48	.292	136	.228	41	.208	79	.245
29	20	.354	110	.326	59	.391	67	.284	58	.216	95	.198	91	.231

TABLE 20 (continued)

Seq.	1		2		3		4		5		6		7	
30	49	.353	36	.319	46	.387	38	.271	3	.214	74	.193	74	.228
31	44	.338	123	.308	43	.378	61	.271	70	.207	54	.178	55	.219
32	91	.334	142	.307	53	.353	43	.268	108	.207	73	.176	18	.217
33	57	.326	101	.297	20	.331	130	.264	128	.200	112	.170	13	.214
34	72	.314	114	.286	83	.312	2	.242	69	.199	38	.168	46	.213
35	32	.311	26	.264	36	.303	62	.242	85	.192	117	.166	66	.191
36	42	.305	43	.261	55	.290	90	.240	140	.190	93	.165	63	.187
37	96	.302	27	.252	60	.282	91	.240	106	.188	70	.165	3	.186
38	137	.301	55	.250	118	.269	13	.239	101	.188	92	.161	59	.186
39	36	.298	96	.239	44	.260	65	.238	2	.173	76	.157	82	.184
40	70	.285	49	.238	101	.255	68	.217	119	.171	22	.155	5	.183
41	21	.282	86	.238	108	.246	46	.216	43	.170	28	.153	49	.182
42	60	.273	103	.237	92	.240	69	.212	67	.170	94	.153	23	.181
43	22	.272	83	.228	94	.238	40	.210	44	.164	18	.150	51	.170
44	58	.255	51	.210	95	.229	21	.206	46	.163	82	.149	20	.170
45	102	.254	131	.208	102	.227	14	.197	29	.159	53	.148	22	.167
46	17	.252	53	.202	12	.223	121	.191	125	.154	109	.139	125	.167
47	135	.251	62	.199	51	.221	120	.188	45	.151	129	.138	38	.167
48	43	.249	87	.189	58	.219	96	.187	4	.149	30	.124	85	.165
49	53	.245	107	.187	16	.211	108	.181	66	.147	138	.118	118	.161
50	71	.241	98	.182	77	.209	77	.179	100	.146	42	.118	48	.160
51	77	.239	89	.175	14	.208	112	.176	40	.146	115	.117	29	.158
52	54	.229	48	.174	61	.208	75	.174	68	.145	106	.117	52	.157
53	136	.228	64	.172	93	.207	36	.174	71	.143	57	.111	102	.157
54	138	.226	88	.160	136	.207	74	.174	34	.142	33	.110	95	.154
55	9	.219	29	.159	1	.200	122	.167	84	.141	68	.107	76	.147
56	31	.208	79	.155	112	.197	42	.165	32	.139	14	.105	101	.145
57	24	.204	8	.153	91	.194	56	.160	54	.138	116	.105	19	.143
58	19	.204	25	.151	9	.193	124	.151	75	.135	107	.104	94	.143
59	129	.204	92	.148	70	.187	53	.150	37	.131	101	.103	45	.140
60	78	.196	39	.147	73	.180	119	.148	74	.128	135	.100	129	.139

TABLE 20 (continued)

Seq.	1		2		3		4		5		6		7	
61	63	.196	80	.145	81	.173	78	.148	31	.127	40	.100	26	.138
62	1	.195	71	.145	41	.170	98	.146	98	.126	31	.097	21	.137
63	52	.188	126	.144	74	.167	10	.138	82	.124	128	.096	108	.137
64	8	.185	93	.141	57	.166	39	.136	10	.123	51	.091	42	.129
65	2	.183	50	.138	45	.165	81	.126	16	.119	85	.090	35	.126
66	41	.182	94	.138	54	.163	1	.125	121	.114	119	.085	105	.119
67	56	.180	6	.138	88	.162	137	.124	73	.113	26	.084	71	.115
68	83	.172	33	.134	105	.159	59	.124	77	.108	114	.084	31	.113
69	106	.169	91	.130	48	.156	22	.123	50	.096	97	.083	109	.112
70	50	.168	13	.128	96	.155	106	.116	39	.092	103	.083	43	.112
71	111	.166	44	.128	84	.149	118	.112	135	.091	72	.083	84	.111
72	16	.159	40	.127	90	.149	63	.111	123	.084	20	.079	126	.107
73	104	.157	1	.127	117	.146	128	.107	118	.080	105	.077	130	.105
74	110	.157	61	.126	30	.144	66	.102	25	.079	23	.076	111	.104
75	126	.147	11	.126	113	.142	109	.101	72	.078	24	.075	25	.104
76	86	.133	59	.123	49	.142	23	.100	9	.077	121	.074	4	.104
77	80	.133	132	.119	8	.139	126	.099	64	.077	25	.074	73	.101
78	88	.133	45	.115	137	.138	97	.097	22	.074	17	.073	30	.093
79	48	.130	28	.107	4	.137	60	.096	49	.073	110	.072	27	.086
80	131	.129	81	.107	6	.131	127	.095	12	.071	120	.069	138	.080
81	39	.128	32	.104	32	.126	47	.092	134	.069	108	.069	115	.080
82	109	.127	63	.101	114	.121	6	.084	137	.067	83	.069	110	.078
83	79	.118	41	.099	47	.119	32	.082	38	.065	52	.068	62	.075
84	38	.116	129	.097	68	.119	113	.081	35	.062	62	.057	98	.072
85	40	.110	66	.093	2	.117	142	.078	105	.062	113	.054	133	.068
86	121	.109	60	.090	103	.117	25	.077	33	.061	142	.054	113	.066
87	98	.108	30	.087	24	.116	114	.071	90	.060	27	.053	131	.062
88	87	.105	95	.082	124	.114	117	.064	41	.059	126	.052	123	.057
89	128	.104	84	.081	72	.111	99	.064	76	.056	111	.050	124	.057
90	12	.101	47	.081	86	.110	101	.061	11	.055	88	.046	97	.057

TABLE 20 (continued)

Seq.	1		2		3		4		5		6		7	
91	35	.101	15	.080	106	.105	95	.060	60	.052	141	.044	36	.050
92	5	.100	69	.077	126	.104	58	.059	104	.048	43	.043	41	.041
93	117	.098	37	.075	52	.102	11	.059	42	.048	39	.042	137	.039
94	81	.097	42	.075	18	.100	105	.056	56	.036	139	.042	64	.037
95	132	.096	68	.073	142	.098	17	.054	78	.034	35	.042	128	.035
96	14	.095	100	.072	127	.095	125	.050	48	.032	75	.041	127	.032
97	112	.087	54	.071	99	.094	100	.049	47	.030	132	.037	132	.022
98	127	.085	24	.067	29	.093	129	.048	1	.023	34	.037	39	.021
99	23	.078	23	.064	104	.088	18	.046	89	.023	122	.033	104	.019
100	11	.077	99	.062	109	.087	138	.041	7	.022	66	.030	68	.019
101	76	.077	34	.056	128	.086	123	.039	5	.020	19	.027	65	.012
102	13	.072	2	.054	122	.078	141	.037	23	.019	69	.027	69	.011
103	61	.068	3	.051	75	.078	131	.036	138	.017	134	.025	119	.010
104	107	.068	10	.050	65	.077	29	.034	81	.013	130	.025	120	.010
105	120	.065	130	.050	11	.075	116	.033	63	.005	60	.022	141	.010
106	59	.060	72	.049	141	.074	19	.029	133	.005	124	.020	99	.007
107	6	.058	97	.049	139	.073	16	.029	26	.004	127	.020	37	.005
108	103	.057	4	.046	10	.072	28	.024	112	.002	64	.019	134	.000
109	105	.057	7	.044	129	.071	15	.024	59	.000	133	.015	116	-.000
110	10	.054	70	.044	50	.069	111	.023	6	-.000	78	.014	11	-.002
111	51	.052	67	.041	15	.068	104	.023	120	-.001	140	.012	89	-.006
112	25	.044	46	.040	5	.068	103	.023	14	-.002	125	.011	86	-.006
113	100	.041	76	.039	97	.067	110	.021	36	-.004	21	.003	114	-.007
114	33	.038	65	.039	123	.065	20	.019	142	-.025	104	.001	140	-.016
115	55	.037	22	.036	135	.064	3	.013	52	-.027	80	-.002	106	-.019
116	114	.028	52	.036	120	.057	136	.003	28	-.028	71	-.002	122	-.019
117	122	.018	140	.035	110	.056	35	-.008	83	-.031	81	-.003	107	-.021
118	27	.017	9	.033	71	.055	132	-.009	62	-.034	100	-.005	117	-.023
119	141	.017	56	.032	121	.055	8	-.010	61	-.034	136	-.007	121	-.026
120	34	.014	77	.025	66	.052	94	-.011	15	-.034	63	-.009	28	-.026

TABLE 20 (continued)

Seq.	1		2		3		4		5		6		7	
121	139	.012	38	.021	140	.049	93	-.014	88	-.040	44	-.015	87	-.026
122	26	.011	57	.018	85	.048	33	-.017	24	-.041	90	-.016	80	-.028
123	130	.008	31	.015	115	.044	31	-.018	96	-.041	137	-.020	112	-.034
124	140	.008	75	.015	69	.042	107	-.019	87	-.054	123	-.021	88	-.035
125	134	.008	102	.006	64	.039	4	-.023	13	-.054	79	-.024	103	-.046
126	133	.007	78	.005	37	.034	135	-.028	80	-.059	67	-.024	100	-.049
127	4	.006	73	.001	130	.034	7	-.029	51	-.061	29	-.031	83	-.050
128	15	-.000	14	-.003	116	.029	30	-.043	91	-.063	98	-.036	6	-.054
129	7	-.001	18	-.005	87	.026	115	-.043	86	-.069	131	-.036	139	-.055
130	62	-.005	35	-.006	132	.020	9	-.044	79	-.073	118	-.077	136	-.056
131	113	-.007	74	-.007	119	.013	34	-.053	27	-.075	36	-.083	135	-.060
132	115	-.011	90	-.015	82	.013	102	-.053	53	-.096	58	-.087	9	-.066
133	119	-.012	16	-.018	7	.003	24	-.055	8	-.109	12	-.092	33	-.067
134	142	-.015	85	-.024	131	.003	92	-.058	30	-.113	99	-.100	10	-.074
135	125	-.017	12	-.025	111	-.005	5	-.059	55	-.121	65	-.103	7	-.076
136	123	-.017	5	-.030	107	-.016	139	-.065	122	-.171	37	-.104	70	-.082
137	116	-.022	20	-.032	17	-.023	27	-.069	141	-.179	102	-.107	34	-.085
138	28	-.043	58	-.052	125	-.035	26	-.070	95	-.268	87	-.110	96	-.139
139	118	-.054	21	-.086	67	-.055	12	-.078	94	-.306	15	-.115	8	-.151
140	108	-.057	82	-.090	89	-.055	140	-.101	139	-.310	86	-.129	142	-.166
141	124	-.087	17	-.176	138	-.060	133	-.138	92	-.325	77	-.133	2	-.231
142	3	-.094	19	-.176	3	-.102	134	-.169	93	-.374	16	-.172	1	-.287

TABLE 21

VARIMAX MATRIX, EVEN-NUMBERED RESPONSES

Seq.	1		2		3		4		5		6		7	
1	65	.651	120	.688	34	.709	7	.525	114	.460	89	.692	70	.657
2	69	.649	117	.679	33	.683	5	.502	127	.386	87	.622	61	.647
3	56	-635	106	.675	43	.654	6	.429	115	.383	90	.577	83	.638
4	49	.624	138	.675	44	.623	4	.383	104	.327	96	.491	60	.617
5	91	.610	122	.672	35	.604	9	.372	130	.316	22	.368	77	.598
6	48	.609	110	.665	32	.596	73	.361	131	.298	82	.361	85	.596
7	75	.595	121	.652	58	.593	2	.347	66	.276	16	.337	42	.547
8	19	.561	109	.599	27	.565	74	.345	129	.258	80	.323	54	.511
9	45	.558	123	.581	26	.563	71	.338	98	.249	112	.303	72	.507
10	47	.558	111	.581	39	.540	81	.238	22	.244	121	.286	79	.489
11	51	.555	119	.574	31	.528	41	.238	45	.235	71	.278	52	.483
12	95	.545	129	.565	134	.527	121	.209	18	.227	122	.271	88	.482
13	98	.544	118	.536	57	.515	55	.193	108	.223	73	.267	67	.468
14	94	.544	128	.530	38	.509	52	.192	116	.217	91	.264	8	.464
15	37	.543	132	.529	13	.503	10	.191	97	.217	86	.260	66	.449
16	93	.535	107	.527	133	.503	120	.189	113	.213	119	.256	24	.446
17	46	.518	105	.523	28	.499	72	.188	73	.204	120	.249	25	.433
18	97	.514	124	.510	14	.494	51	.173	21	.199	88	.240	62	.410
19	101	.504	125	.497	78	.493	122	.168	72	.190	68	.237	84	.398
20	20	.498	135	.493	36	.483	49	.167	141	.189	17	.236	86	.397
21	29	.497	133	.492	80	.469	83	.165	103	.188	6	.222	29	.378
22	86	.496	126	.478	81	.469	85	.158	136	.181	78	.216	1	.369
23	18	.493	102	.468	59	.457	106	.153	111	.172	85	.199	46	.369
24	92	.481	134	.467	64	.433	48	.150	59	.163	13	.197	20	.326
25	68	.479	112	.462	53	.430	21	.142	99	.162	81	.190	68	.320
26	50	.476	136	.456	16	.405	110	.135	126	.160	72	.184	10	.310
27	40	.468	131	.440	55	.384	91	.134	63	.158	92	.183	100	.307
28	67	.467	137	.427	135	.374	64	.132	53	.141	53	.183	45	.290
29	66	.454	103	.417	99	.367	102	.130	71	.137	14	.181	73	.286

TABLE 21 (continued)

Seq.	1		2		3		4		5		6		7	
30	84	.445	113	.412	21	.364	139	.128	3	.137	126	.176	76	.281
31	2	.425	100	.394	47	.359	56	.128	16	.133	140	.172	40	.277
32	71	.397	116	.378	37	.356	105	.126	10	.131	132	.170	50	.252
33	76	.378	130	.350	12	.350	109	.126	128	.125	55	.167	38	.249
34	74	.371	108	.349	82	.348	26	.124	40	.121	109	.165	99	.249
35	78	.369	127	.311	23	.333	86	.117	19	.115	74	.164	15	.249
36	103	.348	104	.300	76	.318	69	.117	41	.114	45	.163	97	.241
37	23	.347	35	.293	25	.309	137	.116	20	.111	63	.155	92	.240
38	73	.337	44	.274	15	.298	14	.115	44	.106	84	.152	71	.231
39	24	.331	53	.225	62	.297	142	.113	39	.098	123	.150	59	.227
40	52	.330	87	.208	51	.288	123	.110	46	.090	125	.149	102	.222
41	36	.330	3	.201	30	.288	28	.109	33	.086	44	.142	9	.218
42	63	.326	98	.196	40	.283	80	.109	61	.086	65	.141	63	.211
43	85	.325	28	.190	60	.272	141	.108	80	.084	15	.136	78	.209
44	77	.325	59	.185	95	.270	76	.106	117	.075	19	.133	17	.198
45	31	.319	97	.180	6	.265	54	.104	29	.073	51	.128	57	.193
46	38	.310	43	.179	74	.262	66	.097	85	.068	2	.126	36	.190
47	104	.308	90	.178	101	.259	16	.097	110	.068	12	.124	96	.185
48	88	.305	89	.176	46	.256	58	.087	125	.066	114	.120	27	.181
49	83	.302	47	.175	105	.245	39	.086	43	.062	21	.117	82	.163
50	16	.301	50	.173	42	.241	94	.084	60	.062	67	.111	69	.161
51	70	.300	10	.171	112	.236	45	.070	70	.060	38	.110	123	.158
52	57	.296	63	.170	98	.235	3	.065	74	.059	106	.105	91	.154
53	111	.292	65	.166	106	.233	50	.060	30	.058	124	.096	80	.149
54	3	.289	6	.165	128	.232	33	.059	37	.056	35	.095	4	.147
55	100	.279	86	.160	79	.232	134	.052	67	.056	115	.093	58	.146
56	41	.277	49	.159	93	.228	77	.047	56	.052	30	.093	35	.139
57	21	.276	27	.158	56	.223	117	.046	11	.050	99	.086	31	.139
58	17	.270	69	.158	119	.218	70	.045	49	.048	20	.075	75	.136
59	54	.257	64	.155	61	.212	107	.044	47	.045	39	.074	51	.133
60	99	.253	55	.155	84	.209	97	.042	13	.042	105	.074	47	.131

TABLE 21 (continued)

Seq.	1		2		3		4		5		6		7	
61	44	.244	62	.154	71	.207	131	.041	23	.041	75	.072	32	.121
62	79	.238	51	.154	48	.203	135	.039	54	.040	36	.068	49	.121
63	14	.232	84	.147	103	.203	90	.038	90	.037	46	.067	55	.121
64	136	.230	26	.145	63	.198	100	.037	87	.035	1	.066	13	.120
65	6	.223	91	.141	54	.196	119	.037	89	.033	43	.058	136	.118
66	12	.221	68	.139	90	.195	98	.034	51	.029	108	.058	37	.118
67	61	.215	1	.139	7	.185	32	.032	118	.018	11	.056	111	.117
68	81	.212	24	.133	92	.184	11	.031	83	.017	110	.052	23	.110
69	87	.206	32	.131	22	.182	133	.030	50	.015	49	.052	121	.109
70	7	.204	99	.130	94	.175	42	.025	34	.011	102	.049	108	.107
71	9	.195	142	.125	50	.174	132	.024	81	.011	77	.047	18	.106
72	123	.189	81	.123	5	.168	53	.022	58	.010	142	.046	128	.101
73	39	.187	75	.121	41	.166	136	.021	124	.005	41	.045	11	.098
74	96	.185	71	.118	11	.165	65	.021	64	.005	139	.043	3	.094
75	82	.184	58	.118	17	.165	43	.020	100	.003	31	.043	65	.093
76	22	.178	21	.115	109	.159	140	.013	135	.001	48	.038	122	.090
77	110	.173	17	.115	85	.144	30	.013	69	-.002	24	.037	48	.089
78	109	.172	5	.111	118	.142	20	.012	8	-.003	29	.936	56	.085
79	62	.171	101	.109	104	.138	114	.003	52	-.008	83	.036	116	.083
80	42	.166	74	.107	49	.134	62	.001	14	-.008	50	.033	39	.082
81	13	.165	60	.106	137	.133	92	-.005	82	-.011	52	.031	93	.082
82	138	.164	139	.105	24	.133	23	-.008	2	-.011	57	.028	51	.079
83	80	.162	56	.105	96	.131	96	-.008	133	-.012	70	.028	106	.073
84	90	.159	48	.100	102	.127	138	-.009	35	-.013	37	.026	135	.072
85	43	.158	141	.098	3	.124	82	-.010	68	-.014	76	.025	127	.067
86	55	.156	82	.098	4	.113	113	-.011	6	-.014	79	.025	118	.067
87	5	.154	15	.097	113	.112	112	-.013	26	-.016	118	.024	22	.066
88	60	.152	7	.096	45	.111	124	-.014	79	-.016	66	.023	98	.064
89	129	.148	61	.096	122	.111	75	-.015	55	-.017	40	.021	19	.063
90	116	.147	25	.093	127	.105	19	-.015	92	-.019	69	.020	132	.062

TABLE 21 (continued)

Seq.	1		2		3		4		5		6		7	
91	53	.144	92	.093	121	.105	89	-.015	109	-.020	107	.019	87	.061
92	118	.144	52	.093	52	.104	44	-.016	42	-.023	54	.017	103	.061
93	127	.143	41	.090	65	.102	118	-.017	27	-.026	7	.017	28	.061
94	72	.142	22	.089	138	.101	29	-.022	107	-.027	42	.016	130	.056
95	34	.131	95	.086	117	.100	37	-.025	112	-.030	94	.016	114	.056
96	25	.124	93	.084	73	.098	115	-.026	134	-.030	113	.006	43	.052
97	114	.119	2	.083	110	.098	68	-.028	48	-.037	4	.002	26	.049
98	137	.112	73	.081	66	.091	40	-.029	65	-.048	56	.001	109	.049
99	64	.102	40	.081	18	.086	63	-.030	38	-.049	64	-.001	138	.047
100	59	.101	76	.080	9	.082	27	-.032	86	-.052	111	-.012	12	.047
101	58	.101	94	.078	120	.082	47	-.033	9	-.055	93	-.013	119	.047
102	117	.098	11	.078	91	.077	34	-.035	32	-.070	3	-.016	16	.044
103	131	.096	140	.077	100	.077	25	-.035	57	-.084	100	-.017	105	.043
104	108	.095	67	.076	114	.077	59	-.044	123	-.084	18	-.017	30	.043
105	128	.091	57	.073	88	.077	129	-.044	77	-.084	26	-.019	5	.043
106	30	.089	77	.071	107	.076	87	-.045	121	-.090	137	-.020	117	.040
107	141	.088	96	.069	129	.069	111	-.049	25	-.092	131	-.024	131	.039
108	113	.084	88	.067	132	.065	88	-.051	76	-.094	47	-.024	120	.036
109	35	.083	29	.065	20	.065	103	-.057	139	-.095	5	-.026	113	.034
110	107	.081	9	.064	2	.063	99	-.057	12	-.099	8	-.030	126	.029
111	102	.078	79	.062	124	.058	67	-.059	132	-.102	59	-.035	53	.029
112	26	.078	19	.060	77	.054	130	-.061	96	-.104	117	-.041	129	.029
113	130	.067	72	.060	131	.050	95	-.073	102	-.105	95	-.041	140	.027
114	105	.075	33	.059	115	.045	46	-.076	119	-.111	61	-.046	7	.021
115	115	.072	114	.058	72	.045	93	-.084	15	-.117	28	-.046	110	.013
116	121	.069	85	.057	67	.040	128	-.086	75	-.118	32	-.049	34	.011
117	126	.066	20	.056	1	.040	18	-.090	120	-.118	97	-.050	107	.009
118	4	.057	31	.053	19	.038	22	-.091	88	-.120	23	-.055	21	.006
119	32	.052	23	.050	75	.038	84	-.093	17	-.125	58	-.055	95	.003
120	15	.048	46	.049	116	.035	57	-.095	7	-.126	127	-.065	101	.002

TABLE 21 (continued)

Seq.	1		2		3		4		5		6		7	
121	125	.042	4	.043	141	.034	104	-.102	31	-.128	27	-.066	94	-.000
122	120	.040	54	.043	69	.031	101	-.106	24	-.129	60	-.069	90	-.005
123	135	.034	16	.042	136	.029	60	-.106	138	-.132	138	-.073	137	-.007
124	27	.031	38	.032	123	.020	61	-.113	1	-.134	34	-.073	64	-.007
125	142	.028	37	.030	111	.014	13	-.118	28	-.141	129	-.076	104	-.010
126	89	.022	42	.029	125	.014	116	-.119	84	-.145	10	-.080	2	-.011
127	132	.016	36	.025	86	.005	108	-.122	78	-.146	25	-.083	44	-.017
128	139	.013	39	.020	83	.004	35	-.127	4	-.148	62	-.085	139	-.018
129	133	.001	34	.018	70	.003	126	-.127	142	-.150	33	-.099	115	-.021
130	140	-.004	45	.013	126	-.009	8	-.131	105	-.183	9	-.099	134	-.027
131	119	-.007	8	.010	108	-.009	127	-.141	91	-.193	128	-.110	124	-.027
132	33	-.008	80	.010	89	-.018	78	-.144	36	-.198	98	-.121	33	-.038
133	124	-.009	14	.005	97	-.027	125	-.154	137	-.203	135	-.131	112	-.040
134	10	-.009	115	.004	87	-.034	38	-.208	5	-.205	103	-.132	125	-.044
135	112	-.016	30	.003	8	-.034	1	-.270	122	-.207	101	-.138	14	-.046
136	1	-.018	13	-.005	29	-.040	24	-.312	140	-.209	116	-.156	142	-.047
137	122	-.025	12	-.006	10	-.041	31	-.318	62	-.244	136	-.165	89	-.061
138	106	-.030	78	-.008	68	-.044	15	-.326	106	-.271	141	-.172	141	-.084
139	28	-.059	70	-.010	142	-.060	36	-.340	101	-.383	104	-.179	133	-.091
140	11	-.063	83	-.019	130	-.081	79	-.344	95	-.386	130	-.182	6	-.171
141	134	-.077	18	-.020	140	-.096	17	-.402	93	-.495	133	-.187	81	-.187
142	8	-.120	66	-.038	139	-.113	12	-.465	94	-.508	134	-.210	74	-.191

TABLE 22

THIRD ORDERED PROMAX MATRIX, ODD-NUMBERED RESPONSES

Seq.	1		2		3		4		5		6		7	
1	69	.583	119	.730	34	.769	86	.560	131	.531	11	.621	15	.599
2	68	.559	105	.675	100	.757	87	.536	110	.488	5	.574	24	.586
3	65	.556	104	.669	33	.701	51	.521	114	.474	9	.536	12	.567
4	92	.547	120	.660	35	.667	88	.474	107	.472	6	.533	16	.563
5	30	.537	141	.147	23	.564	85	.446	129	.455	8	.532	81	.503
6	97	.537	138	.632	27	.528	71	.405	127	.452	10	.491	32	.409
7	95	.533	116	.631	98	.523	70	.376	132	.449	4	.488	77	.398
8	93	.531	113	.615	28	.515	52	.340	111	.435	7	.471	60	.383
9	94	.516	128	.614	25	.502	79	.336	109	.423	2	.321	58	.376
10	66	.509	121	.588	39	.485	41	.331	116	.415	61	.319	75	.349
11	64	.486	106	.576	78	.461	82	.329	12y	.378	1	.318	17	.341
12	89	.482	122	.572	62	.441	84	.326	103	.376	3	.311	54	.324
13	29	.459	137	.561	134	.430	72	.319	117	.344	48	.296	90	.309
14	99	.404	135	.548	31	.429	73	.317	115	.341	32	.262	14	.306
15	74	.342	133	.521	80	.427	45	.314	113	.315	50	.229	67	.306
16	18	.323	136	.510	26	.399	83	.307	130	.312	96	.217	50	.296
17	90	.315	117	.504	19	.396	37	.301	136	.304	13	.195	72	.289
18	37	.310	118	.496	42	.392	89	.296	102	.303	47	.194	53	.261
19	73	.306	111	.471	63	.364	50	.287	18	.288	84	.192	57	.251
20	101	.305	124	.440	38	.350	54	.282	19	.287	56	.184	61	.250
21	47	.294	139	.427	22	.346	55	.281	128	.285	59	.179	56	.248
22	45	.284	134	.405	133	.337	57	.277	20	.282	91	.166	44	.229
23	75	.276	127	.404	56	.326	76	.261	119	.277	55	.163	47	.227
24	137	.248	115	.370	21	.319	49	.255	99	.276	41	.133	78	.218
25	84	.244	109	.369	76	.305	64	.255	97	.276	49	.122	40	.207
26	96	.241	125	.355	40	.300	80	.252	106	.265	46	.119	93	.202
27	36	.239	110	.349	13	.274	48	.249	124	.265	45	.119	92	.195
28	67	.233	108	.323	59	.271	61	.236	3	.217	28	.116	79	.187
29	46	.233	114	.297	79	.256	67	.235	108	.211	54	.112	3	.186

TABLE 22 (continued)

Seq.	1		2		3		4		5		6		7	
30	135	.228	123	.295	43	.255	38	.231	140	.207	74	.110	55	.180
31	82	.221	131	.258	20	.251	44	.231	125	.204	112	.108	91	.176
32	20	.219	142	.254	46	.235	130	.228	101	.201	117	.106	5	.164
33	49	.207	112	.245	83	.212	2	.208	17	.201	38	.104	13	.160
34	91	.204	103	.243	36	.195	62	.200	135	.199	129	.103	125	.158
35	85	.194	101	.239	102	.193	13	.200	121	.187	115	.102	74	.154
36	138	.189	107	.230	53	.177	43	.195	65	.176	95	.098	18	.145
37	136	.182	36	.226	118	.166	91	.191	105	.173	89	.097	59	.138
38	42	.181	26	.202	108	.156	90	.190	104	.169	76	.097	118	.131
39	44	.181	27	.165	1	.141	14	.172	29	.166	109	.090	82	.126
40	102	.171	132	.164	55	.130	65	.168	58	.165	107	.088	51	.123
41	70	.152	43	.160	60	.129	21	.160	69	.154	18	.087	46	.123
42	72	.150	126	.149	136	.123	40	.156	134	.151	22	.085	63	.123
43	1	.149	29	.134	58	.121	46	.150	137	.146	53	.077	66	.120
44	21	.146	49	.126	44	.118	68	.145	4	.144	82	.075	49	.119
45	22	.145	96	.120	101	.116	69	.139	138	.138	93	.074	48	.117
46	57	.140	129	.119	12	.112	96	.138	118	.135	73	.073	52	.116
47	8	.138	55	.111	70	.107	77	.135	57	.135	70	.073	23	.109
48	60	.137	86	.093	112	.100	112	.127	21	.132	14	.071	102	.099
49	104	.136	53	.093	16	.096	108	.122	66	.129	92	.070	38	.099
50	32	.134	15	.091	103	.093	75	.120	123	.125	116	.066	108	.098
51	9	.128	83	.090	9	.093	74	.117	43	.125	94	.061	85	.096
52	53	.126	98	.087	14	.090	10	.114	32	.122	24	.059	26	.095
53	58	.120	64	.075	114	.090	56	.113	2	.114	17	.059	95	.094
54	43	.118	3	.073	77	.089	121	.110	133	.110	33	.056	22	.092
55	17	.117	81	.072	51	.081	36	.109	67	.110	103	.054	29	.092
56	71	.113	62	.070	88	.071	42	.108	34	.100	114	.052	105	.091
57	31	.112	140	.070	142	.071	120	.108	70	.100	26	.051	94	.091
58	77	.106	87	.065	94	.069	122	.108	44	.095	138	.049	20	.089
59	63	.103	48	.062	140	.064	78	.101	68	.094	31	.047	76	.087
60	106	.102	25	.061	2	.063	53	.096	120	.094	40	.043	129	.084

TABLE 22 (continued)

Seq.	1		2		3		4		5		6		7	
61	2	.092	24	.059	41	.063	124	.092	10	.091	30	.040	4	.079
62	83	.092	32	.059	126	.053	1	.092	31	.090	106	.040	101	.072
63	24	.086	99	.057	117	.051	81	.089	46	.086	57	.036	130	.067
64	52	.082	89	.056	95	.050	98	.088	16	.085	42	.034	111	.066
65	111	.079	71	.054	124	.048	59	.086	40	.085	110	.032	19	.065
66	139	.072	51	.053	99	.047	39	.084	100	.085	135	.030	109	.064
67	19	.071	66	.053	4	.047	22	.072	75	.085	128	.030	71	.061
68	129	.069	8	.050	73	.046	63	.065	98	.079	108	.028	138	.061
69	78	.062	50	.049	92	.045	119	.062	9	.074	119	.025	115	.060
70	41	.060	44	.048	96	.043	23	.057	45	.069	25	.024	45	.060
71	80	.057	39	.046	61	.042	6	.057	74	.069	20	.023	126	.057
72	121	.054	11	.046	113	.040	142	.050	85	.066	132	.021	21	.056
73	110	.054	6	.044	127	.039	118	.045	12	.061	23	.021	35	.049
74	86	.054	130	.043	8	.030	60	.044	37	.060	142	.020	42	.047
75	54	.044	92	.043	81	.027	126	.042	71	.060	140	.017	123	.045
76	88	.042	40	.042	57	.025	47	.038	54	.058	101	.016	31	.044
77	87	.037	60	.038	6	.024	66	.033	11	.057	126	.015	25	.040
78	39	.037	33	.031	91	.022	137	.032	84	.053	105	.014	30	.039
79	128	.035	102	.031	74	.021	25	.029	77	.051	27	.011	27	.037
80	131	.034	59	.029	86	.021	17	.029	39	.045	51	.009	113	.035
81	126	.033	94	.026	123	.019	11	.028	25	.043	139	.009	84	.035
82	141	.032	93	.026	105	.014	106	.026	50	.037	72	.007	43	.035
83	16	.030	79	.021	132	.013	109	.024	7	.034	111	.004	133	.034
84	112	.028	1	.021	129	.012	32	.023	26	.032	52	.004	124	.033
85	120	.025	30	.020	30	.011	97	.021	33	.032	113	.004	110	.031
86	117	.019	97	.019	93	.009	127	.019	49	.032	85	-.001	73	.022
87	56	.019	88	.017	48	.006	128	.018	64	.031	130	-.001	62	.019
88	122	.017	91	.014	130	.005	58	.015	60	.023	121	-.001	131	.018
89	132	.017	69	.014	45	.005	95	.012	82	.019	62	-.005	141	.010
90	98	.010	63	.014	54	.001	114	.008	5	.018	125	-.005	128	.000

TABLE 22 (continued)

Seq.	1		2		3		4		5		6		7	
91	109	.006	47	.013	90	-.001	125	.006	22	.015	120	-.005	98	-.004
92	35	.006	61	.012	137	-.001	15	.004	73	.013	35	-.005	104	-.007
93	105	.002	28	.011	52	-.004	123	.002	112	.013	34	-.006	119	-.008
94	79	-.004	4	.011	109	-.005	99	.002	47	.012	19	-.007	137	-.008
95	142	-.005	67	.008	110	-.005	100	.001	142	.010	68	-.010	36	-.009
96	107	-.006	7	.006	84	-.006	3	-.002	35	.005	141	-.011	120	-.010
97	50	-.007	37	.005	10	-.006	113	-.002	1	.004	134	-.012	41	-.011
98	140	-.007	80	.003	139	-.008	28	-.004	6	-.003	97	-.013	127	-.013
99	127	-.008	13	-.002	18	-.008	16	-.007	36	-.004	124	-.014	132	-.014
100	5	-.009	12	-.004	65	-.008	19	-.011	72	-.007	83	-.020	116	-.023
101	48	-.010	45	-.004	68	-.010	129	-.012	81	-.011	75	-.024	11	-.025
102	12	-.011	16	-.006	115	-.011	18	-.017	90	-.012	39	-.025	122	-.026
103	134	-.012	77	-.008	106	-.014	117	-.019	48	-.014	127	-.025	97	-.027
104	103	-.012	68	-.013	131	-.015	101	-.023	42	-.016	133	-.028	140	-.028
105	133	-.012	54	-.013	29	-.020	141	-.025	41	-.019	81	-.029	64	-.035
106	27	-.026	65	-.014	107	-.026	131	-.026	89	-.021	60	-.031	134	-.041
107	38	-.026	18	-.014	49	-.027	103	-.031	24	-.027	122	-.032	139	-.042
108	33	-.027	41	-.017	104	-.033	105	-.031	38	-.028	88	-.040	86	-.048
109	14	-.028	10	-.023	128	-.033	7	-.037	15	-.031	123	-.042	114	-.050
110	6	-.029	75	-.024	37	-.034	29	-.037	56	-.032	43	-.047	39	-.050
111	11	-.030	34	-.024	97	-.036	8	-.038	59	-.034	78	-.048	107	-.052
112	81	-.033	100	-.024	135	-.042	20	-.041	76	-.035	100	-.060	37	-.053
113	23	-.034	9	-.039	122	-.042	138	-.042	63	-.036	66	-.061	121	-.056
114	100	-.040	2	-.040	87	-.043	116	-.047	23	-.042	131	-.062	87	-.058
115	40	-.041	72	-.040	72	-.044	4	-.049	78	-.044	21	-.062	106	-.059
116	123	-.044	42	-.041	11	-.048	35	-.049	96	-.047	104	-.068	99	-.060
117	10	-.047	84	-.041	71	-.046	110	-.054	141	-.049	63	-.070	117	-.064
118	7	-.047	95	-.041	47	-.048	132	-.056	28	-.053	136	-.079	112	-.067
119	26	-.047	23	-.043	116	-.048	111	-.057	27	-.055	80	-.084	68	-.067
120	34	-.047	31	-.044	15	-.050	94	-.058	14	-.062	71	-.084	89	-.069

TABLE 22 (continued)

Seq.	1		2		3		4		5		6		7	
121	59	-.051	58	-.051	7	-.050	93	-.060	122	-.079	69	-.086	69	-.071
122	25	-.052	20	-.052	141	-.050	104	-.063	8	-.085	67	-.088	28	-.072
123	76	-.057	57	-.054	24	-.051	33	-.064	61	-.085	12	-.090	65	-.073
124	13	-.061	22	-.060	5	-.053	31	-.064	83	-.087	90	-.094	6	-.078
125	119	-.066	52	-.064	121	-.061	107	-.069	62	-.087	44	-.098	7	-.079
126	114	-.070	46	-.064	32	-.063	5	-.075	30	-.095	64	-.098	88	-.080
127	125	-.071	70	-.069	69	-.068	9	-.079	91	-.104	79	-.099	103	-.084
128	115	-.074	14	-.070	85	-.069	136	-.085	52	-.108	98	-.102	135	-.092
129	113	-.075	5	-.073	75	-.072	24	-.091	13	-.112	15	-.108	80	-.093
130	116	-.083	56	-.076	120	-.079	30	-.094	53	-.114	29	-.112	10	-.101
131	55	-.083	76	-.076	66	-.081	139	-.095	80	-.130	137	-.113	83	-.105
132	61	-.083	74	-.080	111	-.089	34	-.096	88	-.131	58	-.119	136	-.106
133	51	-.085	90	-.082	64	-.092	115	-.097	87	-.140	118	-.122	9	-.107
134	15	-.094	35	-.093	50	-.100	102	-.102	79	-.152	102	-.138	100	-.132
135	62	-.096	78	-.094	17	-.100	12	-.106	51	-.157	36	-.170	33	-.139
136	28	-.097	38	-.097	82	-.100	135	-.109	86	-.158	99	-.17z	70	-.153
137	4	-.103	73	-.115	119	-.102	92	-.110	55	-.161	77	-.179	34	-.160
138	118	-.113	85	-.121	125	-.103	27	-.114	139	-.195	16	-.186	8	-.175
139	130	-.114	17	-.150	3	-.153	26	-.118	95	-.273	87	-.190	142	-.175
140	124	-.157	21	-.152	67	-.182	140	-.118	94	-.283	37	-.191	96	-.185
141	108	-.160	82	-.169	138	-.208	133	-.210	92	-.290	65	-.212	2	-.278
142	3	-.184	19	-.187	89	-.208	134	-.234	93	-.346	86	-.222	1	-.327

TABLE 23

THIRD ORDERED PROMAX MATRIX, EVEN-NUMBERED RESPONSES

Seq.	1		2		3		4		5		6		7	
1	69	.547	117	.640	33	.660	7	.547	127	.482	89	.696	70	.607
2	94	.545	138	.632	34	.657	5	.519	104	.481	87	.607	83	.602
3	65	.544	120	.611	43	.580	6	.450	114	.431	90	.565	61	.574
4	95	.528	110	.602	32	.533	4	.399	130	.420	96	.450	60	.550
5	56	.521	106	.601	44	.531	73	.399	129	.417	22	.380	77	.538
6	93	.516	122	.594	35	.526	9	.391	98	.400	112	.359	85	.531
7	75	.516	121	.562	58	.526	71	.387	131	.385	82	.343	42	.494
8	101	.508	129	.543	27	.507	74	.378	111	.369	121	.313	72	.480
9	49	.505	111	.538	26	.501	2	.378	103	.369	119	.309	54	.460
10	48	.505	109	.516	39	.482	81	.279	115	.357	122	.309	8	.458
11	91	.492	123	.511	134	.464	41	.266	116	.356	16	.304	52	.438
12	19	.460	119	.500	13	.455	52	.239	97	.347	80	.298	88	.400
13	98	.433	128	.497	28	.451	55	.234	18	.334	120	.287	66	.385
14	47	.426	107	.490	31	.430	51	.232	136	.333	126	.248	79	.384
15	51	.418	118	.487	14	.429	85	.219	108	.317	17	.241	25	.380
16	37	.410	124	.484	133	.428	72	.218	113	.303	125	.224	67	.377
17	97	.393	132	.482	80	.417	83	.217	45	.290	132	.214	62	.355
18	18	.393	125	.479	38	.413	49	.216	66	.282	53	.207	24	.338
19	45	.367	126	.455	57	.412	48	.211	126	.280	71	.201	10	.330
20	29	.357	105	.448	81	.402	91	.197	128	.279	13	.197	1	.318
21	2	.355	135	.440	59	.399	56	.188	22	.246	109	.195	86	.313
22	20	.342	133	.440	78	.384	21	.180	19	.245	73	.194	29	.302
23	50	.339	136	.432	36	.380	14	.180	117	.240	88	.181	84	.287
24	68	.331	134	.418	64	.375	121	.178	110	.225	86	.173	46	.257
25	46	.329	131	.418	53	.371	80	.176	63	.223	68	.172	100	.249
26	92	.329	102	.406	16	.333	10	.174	141	.219	78	.171	73	.247
27	86	.317	112	.394	55	.307	76	.171	3	.218	44	.169	20	.244
28	74	.304	113	.383	12	.299	86	.169	21	.213	6	.167	9	.230
29	40	.302	116	.377	21	.295	26	.166	40	.209	15	.166	68	.229

TABLE 23 (continued)

Seq.	1		2		3		4		5		6		7	
30	67	.285	137	.376	135	.288	69	.162	125	.209	81	.164	76	.207
31	84	.277	130	.372	99	.288	64	.161	47	.205	123	.164	45	.199
32	103	.263	103	.364	82	.280	16	.161	99	.197	124	.160	102	.190
33	66	.252	108	.337	30	.262	54	.157	20	.195	91	.154	40	.179
34	23	.248	100	.332	15	.253	66	.154	56	.190	140	.152	97	.174
35	104	.246	127	.300	23	.241	94	.152	49	.184	114	.150	71	.172
36	76	.238	104	.277	37	.228	39	.147	46	.184	106	.149	4	.171
37	36	.214	35	.199	25	.227	120	.147	59	.180	14	.148	50	.170
38	78	.206	10	.158	47	.208	58	.138	44	.177	72	.146	99	.163
39	31	.203	44	.154	76	.192	28	.134	29	.176	12	.144	59	.161
40	111	.202	3	.145	6	.189	45	.133	37	.170	35	.144	15	.160
41	3	.202	53	.133	60	.187	122	.132	118	.168	63	.144	92	.141
42	71	.200	1	.132	62	.186	106	.122	53	.164	55	.143	38	.128
43	24	.195	28	.122	112	.180	102	.117	69	.162	85	.129	63	.127
44	136	.168	87	.121	74	.172	105	.113	73	.148	115	.122	27	.122
45	63	.168	97	.120	40	.162	139	.112	67	.140	92	.120	123	.108
46	41	.166	59	.117	11	.161	50	.107	51	.133	108	.116	96	.106
47	17	.165	98	.115	42	.158	109	.104	65	.132	21	.103	41	.102
48	100	.162	142	.110	22	.153	33	.103	100	.129	74	.100	57	.093
49	52	.159	89	.103	128	.148	142	.102	50	.128	110	.100	58	.090
50	57	.158	141	.098	79	.148	77	.101	16	.120	105	.099	11	.087
51	6	.156	139	.098	90	.144	137	.100	41	.117	38	.096	78	.084
52	7	.153	63	.087	51	.140	70	.097	23	.117	84	.096	136	.081
53	12	.149	27	.085	105	.138	110	.093	124	.116	1	.092	69	.078
54	77	.147	62	.084	119	.133	141	.091	71	.116	45	.092	17	.076
55	38	.145	24	.080	46	.123	123	.086	109	.112	30	.090	82	.075
56	21	.144	64	.077	106	.119	42	.082	107	.107	99	.090	80	.075
57	73	.139	50	.077	61	.118	32	.081	61	.106	43	.079	55	.070
58	138	.137	90	.070	95	.109	3	.077	135	.105	11	.075	121	.067
59	88	.129	43	.069	98	.108	65	.076	72	.105	118	.074	32	.065
60	81	.128	47	.067	63	.108	43	.074	133	.103	19	.072	5	.065

TABLE 23 (continued)

Seq.	1		2		3		4		5		6		7	
61	16	.128	140	.063	101	.104	90	.070	68	.096	113	.067	108	.061
62	9	.127	17	.061	54	.099	98	.068	10	.095	107	.064	36	.058
63	5	.123	69	.060	7	.096	20	.065	48	.095	102	.064	91	.057
64	14	.120	65	.056	71	.094	97	.064	74	.089	39	.062	122	.055
65	83	.109	15	.055	103	.088	92	.059	138	.087	65	.061	111	.049
66	137	.103	26	.054	41	.087	53	.052	43	.085	51	.056	128	.046
67	70	.101	68	.053	17	.083	37	.050	92	.076	36	.055	3	.046
68	110	.101	11	.053	5	.080	62	.049	39	.074	67	.051	130	.045
69	123	.099	6	.051	114	.080	30	.048	60	.071	31	.042	116	.043
70	116	.098	60	.049	56	.068	82	.046	87	.070	131	.039	75	.043
71	141	.093	55	.049	127	.068	23	.045	79	.069	111	.036	35	.042
72	44	.091	86	.047	96	.066	96	.041	75	.060	2	.035	106	.040
73	85	.083	49	.047	104	.064	100	.041	123	.056	117	.032	23	.037
74	129	.081	32	.046	115	.064	134	.039	33	.051	79	.029	49	.037
75	99	.079	99	.045	84	.061	75	.037	134	.049	142	.029	7	.035
76	109	.077	84	.043	113	.059	11	.037	70	.049	139	.026	28	.034
77	118	.074	61	.037	4	.057	40	.034	35	.046	24	.021	135	.030
78	79	.073	25	.034	93	.057	34	.034	30	.041	46	.013	13	.026
79	54	.070	101	.033	92	.054	44	.033	13	.040	20	.012	18	.025
80	87	.066	75	.033	48	.047	19	.031	112	.038	57	.009	132	.022
81	62	.058	114	.029	118	.042	47	.030	85	.033	127	.008	114	.022
82	142	.053	5	.026	109	.041	135	.026	90	.032	129	.004	140	.021
83	127	.051	8	.025	3	.041	29	.023	2	.031	64	.002	47	.019
84	130	.046	58	.025	50	.035	133	.017	12	.027	59	.002	39	.015
85	107	.046	51	.023	137	.034	68	.016	86	.026	51	.000	127	.015
86	39	.043	21	.018	85	.031	119	.016	54	.025	75	-.008	131	.012
87	117	.041	22	.017	102	.024	25	.013	34	.021	26	-.012	118	.011
88	96	.036	79	.014	141	.019	140	.012	38	.021	137	-.012	37	.011
89	139	.033	91	.011	24	.016	27	.012	80	.016	8	-.013	31	.009
90	22	.025	41	.010	73	.007	107	.009	64	.016	42	-.019	48	.003

TABLE 23 (continued)

Seq.	1		2		3		4		5		6		7	
91	34	.025	81	.006	122	.007	88	.008	17	.015	100	-.019	26	.002
92	64	.023	52	.004	94	.004	63	.007	81	.014	40	-.019	105	.001
93	55	.021	9	.001	124	.001	114	.005	11	.013	50	-.021	30	.001
94	131	.019	7	-.000	1	.000	131	.001	24	.011	77	-.021	117	.000
95	82	.017	29	-.001	18	.000	46	-.001	89	.009	138	-.021	120	-.000
96	105	.017	77	-.005	9	-.001	95	-.002	132	.005	3	-.025	139	-.002
97	108	.015	67	-.005	117	-.002	67	-.003	52	.001	28	-.026	113	-.005
98	13	.013	74	-.007	131	-.002	117	-.004	58	.001	29	-.029	138	-.005
99	128	.012	95	-.008	45	-.007	132	-.006	31	-.000	37	-.030	56	-.005
100	43	.011	115	-.008	66	-.008	99	-.008	121	-.001	128	-.030	109	-.008
101	90	.010	56	-.008	121	-.009	136	-.008	120	-.007	49	-.031	119	-.009
102	113	.009	82	-.010	107	-.010	93	-.009	57	-.013	54	-.032	51	-.013
103	4	.007	93	-.011	129	-.010	89	-.009	14	-.015	32	-.035	103	-.014
104	30	.005	72	-.012	72	-.013	59	-.010	82	-.015	27	-.036	65	-.014
105	61	.004	92	-.013	132	-.015	57	-.020	27	-.015	70	-.036	22	-.015
106	53	.004	40	-.014	52	-.016	84	-.025	83	-.016	76	-.038	129	-.018
107	125	.004	33	-.016	110	-.019	115	-.027	119	-.019	52	-.040	93	-.019
108	140	.002	48	-.016	49	-.025	112	-.027	26	-.022	66	-.042	98	-.021
109	114	-.003	2	-.016	116	-.026	87	-.029	102	-.025	83	-.047	87	-.024
110	115	-.004	71	-.017	120	-.027	113	-.039	84	-.029	58	-.049	107	-.024
111	126	-.008	4	-.019	89	-.027	118	-.040	6	-.029	48	-.051	126	-.026
112	25	-.012	88	-.019	138	-.031	101	-.044	55	-.033	18	-.055	19	-.027
113	102	-.013	19	-.021	88	-.033	18	-.044	76	-.038	61	-.055	110	-.031
114	42	-.018	94	-.026	8	-.036	138	-.046	8	-.047	34	-.059	43	-.033
115	26	-.027	76	-.026	125	-.039	78	-.047	42	-.049	4	-.061	137	-.034
116	80	-.027	23	-.026	2	-.048	13	-.048	77	-.054	47	-.064	142	-.039
117	58	-.029	20	-.027	100	-.050	124	-.055	91	-.057	33	-.065	2	-.042
118	133	-.034	57	-.028	108	-.053	60	-.056	15	-.059	7	-.068	115	-.044
119	135	-.035	96	-.029	20	-.056	103	-.059	32	-.066	135	-.068	16	-.045
120	120	-.035	31	-.034	126	-.061	22	-.060	36	-.068	69	-.068	53	-.045

TABLE 23 (continued)

Seq.	1		2		3		4		5		6		7	
121	121	-.040	73	-.034	65	-.063	61	-.061	105	-.073	60	-.069	64	-.046
122	132	-.041	54	-.039	136	-.068	111	-.080	25	-.074	10	-.078	134	-.056
123	124	-.042	42	-.043	77	-.069	35	-.084	9	-.078	56	-.079	21	-.056
124	60	-.049	12	-.051	10	-.074	129	-.089	137	-.078	23	-.083	124	-.059
125	59	-.052	85	-.052	19	-.078	130	-.110	139	-.079	97	-.091	34	-.064
126	32	-.057	46	-.053	67	-.087	104	-.111	78	-.080	116	-.094	104	-.070
127	15	-.060	30	-.053	142	-.091	128	-.111	1	-.082	25	-.096	141	-.074
128	72	-.066	36	-.061	87	-.092	38	-.122	88	-.083	103	-.097	12	-.075
129	35	-.067	38	-.069	91	-.094	8	-.123	96	-.109	94	-.100	94	-.078
130	106	-.084	70	-.072	70	-.095	108	-.147	122	-.114	93	-.107	33	-.080
131	89	-.089	34	-.072	83	-.100	116	-.148	142	-.118	5	-.107	90	-.087
132	27	-.089	18	-.074	111	-.106	127	-.161	28	-.150	133	-.109	101	-.090
133	10	-.096	37	-.078	123	-.107	126	-.164	106	-.154	130	-.113	95	-.098
134	119	-.097	39	-.082	130	-.112	125	-.192	101	-.160	62	-.114	125	-.098
135	33	-.099	16	-.084	75	-.116	31	-.235	7	-.162	95	-.122	112	-.099
136	112	-.100	45	-.091	140	-.119	36	-.252	95	-.176	136	-.125	14	-.116
137	1	-.101	83	-.093	139	-.135	1	-.254	62	-.187	134	-.129	44	-.122
138	122	-.104	13	-.098	69	-.135	24	-.258	140	-.189	104	-.133	89	-.122
139	134	-.119	14	-.108	86	-.146	15	-.281	4	-.211	98	-.144	133	-.133
140	28	-.125	80	-.112	97	-.151	79	-.283	5	-.234	141	-.159	6	-.190
141	11	-.127	66	-.119	29	-.164	17	-.350	93	-.284	9	-.169	74	-.232
142	8	-.212	78	-.130	68	-.174	12	-.400	94	-.322	101	-.204	81	-.240

APPENDIX B



Figure 1. Physical Testing Technician Questionnaire

AMERICAN SOCIETY FOR TESTING AND MATERIALS

1916 RACE STREET PHILADELPHIA, PA. 19103

COMMITTEE D-20 ON PLASTICS

Organized in 1937

CHAIRMAN: P. J. THOMA, SANDIA CORP., DIV. 4222, BOX 5800, ALBUQUERQUE, N.M. 87115

VICE-CHAIRMAN (METHODS): J. H. ROSS, JR., UNION CARBIDE CORP., CHEMICAL DIV., BOX 8361, SOUTH CHARLESTON, W. VA. 25303

VICE-CHAIRMAN (MATERIALS): K. C. FORD, CSA TESTING LABS., 178 REXDALE BLVD., REXDALE, ONT., CANADA

VICE-CHAIRMAN (LIAISON-RESEARCH-SPECIAL): D. E. CRAWFORD, USS CHEMICALS, 1820 GRANT BLDG., PITTSBURGH, PA. 15230

VICE-CHAIRMAN (MEMBERSHIP ORIENTATION): G. D. PATTERSON, JR., E. I. DUPONT DE NEMOURS & CO., INC., EXPERIMENTAL STATION, FILM DEPT., WILMINGTON, DEL. 19898

GENERAL SECRETARY: P. E. CAMPBELL, PHILLIPS PETROLEUM CO., CHEM. DEPT., PLASTICS SERVICES DIV., BARTLEVILLE, OKLA. 74004

STAFF ASSISTANT: W. F. HULSE, ASTM, 1916 RACE ST., PHILADELPHIA, PA. 19103

REPLY TO: Plastics Survey
The University of Tennessee
P. O. Box 9
Kingsport, Tennessee 37662

DEADLINE: October 8, 1971

Dear D-20 Member:

A vital part of ASTM's new effort is directed toward educational needs. Technical training is difficult, at best, in a dynamic industry such as plastics. An opportunity is hereby provided for you to participate in a survey on the current training needs of physical testing technicians for plastics. In cooperation with The University of Tennessee, the attached questionnaire is being administered through Committee D-20 to physical testing technicians and their supervisors in a large number of companies to better define proper training objectives for the skill.

Your participation in this study is extremely important, for we are depending on you to distribute the questionnaire and answer sheets to the proper people throughout your organization. By physical testing technicians and supervisors, we mean those who are engaged in plastics tests and evaluations in all areas under the scope of Committee D-20. Secure as many respondents as possible, including those at all levels of skill.

Three "Questionnaire Forms" and six separate "Answer Sheets" are attached. Only the "Answer Sheets" are to be returned and must be sent directly to the University, after completion. With these forms, six respondents can be accommodated since the questionnaires can be shared. Since responses are handled by computor, additional participants are desired where available. If additional forms or sheets can be used, they will be provided upon request to the University, or you may make your own additional copies by use of any convenient copying machine. The items on the questionnaire are easily answered and trial runs have shown that it takes about 30 minutes to complete.

The results of this study will be published and made available to your organization at no charge. Information will be categorized by industry, but information pertaining to specific companies will be treated confidentially. The success of this program depends on your contribution, so distribute the questionnaires and answer forms so that they can be completed and returned by the October 8 deadline.

Sincerely,

WF Hulse

The questionnaire sections contain only questions and other information requested, and may be used by several respondents. Answer Sheets are to be completed individually and mailed to the University, as indicated.

Evaluate the importance of each item on a scale from "0" to "5" with the "0" given to items of no importance and "5" ranked as the most important. As a physical testing technician or supervisor, you may consider an item important because it occurs frequently, is very relevant to your job, or other reasons.

Ranking	Relative Importance
0.	DOES NOT APPLY. Definitely not part of my job duties.
1.	INSIGNIFICANT. Rarely encountered in my job.
2.	MINOR IMPORTANCE. Encountered occasionally.
3.	MODERATE IMPORTANCE. Frequently a part of my job.
4.	VERY IMPORTANT. A regularly occurring part of my job.
5.	EXTREMELY IMPORTANT. Vital and utmost in my job performance.

Rank each of the following job items, circling your answer on the attached answer sheets. Answer all items. Do not leave blanks. To aid in matching the proper question with the answer sheet, place one sheet on top of the other, as indicated, matching the column letters and arrows.

COLUMN A

A →

I. PLASTIC MATERIALS

My job requires me to work with:

1-19. THERMOPLASTICS

1-20. THERMOSETTING PLASTICS.

1-21. Reinforced plastics.

1-22. Laminates.

1-23. Experimental materials.

1-24. ABS

1-25. Acetal

1-26. Acrylates and methacrylates.

1-27. Allyl compounds.

1-28. Cellulosics.

1-29. Epoxies.

A →

Place ANSWER SHEET here: →

To answer Column A, place edge of answer sheet on line.

COLUMN B

B →

1-30. Fluorocarbons.

1-31. Melamines.

1-32. Nylon.

1-33. Olefins (polyethylene, polypropylene, others).

1-34. Phenolics.

1-35. Polycarbonates.

1-36. Polyesters.

1-37. Polystyrene.

1-38. Polyurethane.

1-39. Polyvinyl chloride.

1-40. Urea formaldehyde.

II. SAMPLE PREPARATION

B →

Place ANSWER SHEET here: →

Place response on proper answer sheet. Place next to answer sheet as indicated.

COLUMN C

C →

My job duties require that I:

1-41. Prepare powder blends.

1-42. Mill plastic materials.

1-43. Prepare dispersions.

1-44. Apply plastic coatings.

1-45. Make castings.

1-46. Roto- or slush moldings.

1-47. Pelletize.

1-48. Extrude.

1-49. Prepare laminates.

1-50. Compression moldings.

1-51. Injection moldings.

1-52. Die cuttings.

1-53. Condition to a specified temperature.

1-54. Condition to a specified humidity.

1-55. Machine specimens.

III. TOOLS AND EQUIPMENT

My job requires that I use a:

1-56. Analytical balance.

1-57. Cold chamber.

1-58. Oven.

1-59. Muffle furnace.

1-60. Constant temperature bath.

1-61. Pressurizing system.

1-62. Hydrometer.

C →

Place ANSWER SHEET here: →

To answer Column C, place edge of answer sheet on line.

COLUMN D

D →

1-63. Pycnometer.

1-64. Brookfield viscometer.

1-65. Extrusion rheometer.

1-66. Torque rheometer.

1-67. Photometric unit.

1-68. Refractometer.

1-69. Nessler tubes.

1-70. Spectrophotometer.

1-71. Color reference system.

1-72. Infrared analyzer.

1-73. Gas chromatograph.

1-74. Potentiometric titrator.

1-75. Impact machine.

1-76. Testing machine for mechanical properties.

1-77. Oxygen bomb.

1-78. Electrical measurement apparatus.

1-79. Sieves.

1-80. Vacuum system.

(Numbers 2-01 through 2-05 are for computor use only. Leave these blank.)

2-06. Soxhlet extractor.

2-07. Accelerated weathering equipment.

D →

Place ANSWER SHEET here: →

Place response on proper answer sheet. Place next to answer sheet as indicated.

COLUMN E

E →

IV. TESTS

My job duties require that I perform or determine:

2-08. Titrations.

2-09. Acidity and basicity.

2-10. Filtrations.

2-11. Normalities of solutions.

2-12. Compositions of plastic materials.

2-13. Refluxing.

2-14. Sieve analysis.

2-15. Statistical sampling.

2-16. Specific gravity.

2-17. Dimensions and tolerance.

2-18. Particle size.

2-19. Freezing point.

2-20. Boiling point.

2-21. Ash content.

2-22. Density.

2-23. Odor.

2-24. Open cell content (foam).

2-25. Porosity.

2-26. Blocking.

2-27. Moisture content.

2-28. Solvent extraction resistance.

2-29. Chemical resistance.

2-30. Volatile matter.

2-31. Environmental stress cracking.

E →

Place ANSWER SHEET here: →

To answer Column E, place edge of answer sheet on line.

COLUMN F

F →

2-32. Shrinkage.

2-33. Warpage.

2-34. Brittleness temperature.

2-35. Weight loss on oven aging.

2-36. Oven heat stability.

2-37. Oxygen index.

2-38. Flammability.

2-39. Smoke density.

2-40. Dimensional changes during heating.

2-41. Accelerated service conditions.

2-42. Accelerated weathering.

2-43. Outdoor weathering.

2-44. Water immersion stability.

2-45. Underground stability.

2-46. Water vapor transmission.

2-47. Gas transmission.

2-48. Compatibility.

2-49. Thermal oxidation.

2-50. Permeability.

2-51. Stain resistance.

2-52. Fungi resistance.

2-53. Bacteria resistance.

2-54. Water absorption.

2-55. Water extraction.

2-56. Plasticizer absorption.

2-57. Low temperature flexibility.

F →

Place ANSWER SHEET here: →

Place response on proper answer sheet. Place next to answer sheet as indicated.

COLUMN G

G →

2-58. Refractive index.

2-59. Haze.

2-60. Color difference.

2-61. Turbidity.

2-62. Optical clarity.

2-63. Luminous transmittance.

2-64. Flatness or gloss.

2-65. Crocking.

2-66. Spectral transmittance.

2-67. Suspended matter.

2-68. Classify visual defects.

2-69. Gardner color.

2-70. APHA color.

2-71. Deformation under load.

2-72. Deflection temperature under load.

2-73. Tensile properties.

2-74. Tear strength.

2-75. Izod impact strength.

2-76. Low temperature impact strength.

2-77. Free falling dart impact strength.

2-78. Falling weight impact strength.

2-79. Flexural strength.

2-80. Flexural modulus of elasticity.

(Numbers 3-01 through 3-05 are for computor use only. Leave these numbers blank.)

G →

Place ANSWER SHEET here: →

To answer Column G, place edge of answer sheet on line.

COLUMN H

H →

3-06. Modulus of elasticity.

3-07. Film yield.

3-08. Delamination strength.

3-09. Lap shear strength.

3-10. Column crush properties (containers).

3-11. Shrink tension.

3-12. Orientation release stress.

3-13. Bond strength.

3-14. Flexural stress (fatigue).

3-15. Barcol hardness.

3-16. Durometer hardness.

3-17. Rockwell hardness.

3-18. Vicat softening point.

3-19. Mar resistance.

3-20. Durran's softening point.

3-21. Coefficient of friction.

3-22. Flow rate.

3-23. Pourability.

3-24. Relative viscosity.

3-25. Melting point or melt index.

3-26. Dry flow.

3-27. Sag flow.

3-28. Gel time.

3-29. Peak exotherm.

H →

Place ANSWER SHEET here: →

Place response on proper answer sheet. Place next to answer sheet as indicated.

COLUMN I

I →

3-30. Fusion by torque rheometer.
3-31. Fusion by solvent resistance.
3-32. Film Stress.
3-33. Film strain.
3-34. Void content (solids).
3-35. Thermal stress crack resistance.
3-36. Abrasion resistance.
3-37. Resistance to puncture propagation.
3-38. Resistance to tear propagation.
3-39. Creep and stress relaxation.
3-40. Sustained pressure resistance.
3-41. Burst pressure (pipe or container.
3-42. Flattening pressure (pipe)
3-43. Orientation release stress.
3-44. Hydrostatic compressive strength.
3-45. Joint strength (pipe).
3-46. Compressive properties.
3-47. Pipe threading qualities.
3-48. Brittleness temperature.
3-49. Coefficient of expansion.
3-50. Ignition properties.
3-51. Tensile heat distortion temperature.
3-52. Dielectric strength.
3-53. Dissipation factor.
3-54. Electrical loss factor.
3-55. Arc resistance.

I →

Place ANSWER SHEET here: →

To answer Column I, place edge of answer sheet on line.

COLUMN J

J →

3-56. Insulation resistance.
3-57. Volume resistivity.
3-58. Surface resistivity.
3-59. Plastic welding performance.

V. CALCULATIONS.

My job duties require that I calculate:

3-60. Thermal conductivity.
3-61. Strength of materials.
3-62. Modulus values.
3-63. Per cent loss or gain.
3-64. Molecular weights.
3-65. Relative viscosities, shear forces and stresses.
3-66. Arithmetic means (averages).
3-67. Standard deviations.
3-68. Normality of solutions.
3-69. Electrical properties.
3-70. English and metric equivalents.
3-71. Statistical confidence limits.

VI. CLERICAL DUTIES

My job duties require that I:

3-72. Maintain laboratory notebooks.
3-73. Be proficient in use of laboratory files.
3-74. Keep time, production, or clerical records.
3-75. Maintain records of materials tested.
3-76. Conduct studies and write reports.

J →

Place ANSWER SHEET here: →

Place response on proper answer sheet. Place next to answer sheet as indicated.

COLUMN K

K →

3-77. Prepare material for technical publications.
3-78. Read trade or technical publications.
3-79. Prepare verbal reports for meetings.
3-80. Review new test methods regularly.

(Numbers 4-01 through 4-05 are for computor use only. Leave these blank.)

VII. RESPONSIBILITIES

My job duties require that I:

4-06. Consider economy.
4-07. Consider safety.
4-08. Consider quality.
4-09. Consider production methods.
4-10. Consider limitations of others.
4-11. Meet project deadlines.
4-12. Determine work procedures
4-13. Make optimum use of time and materials.
4-14. Assist others in acquiring information.
4-15. Assume responsibility for results.
4-16. Enforce specifications on materials.
4-17. Work with government classified information.
4-18. Assume compliance with company policy.
4-19. Recommend changes to supervision.

K →

Place ANSWER SHEET here: →

To answer Column K, place edge of answer sheet on line.

COLUMN L

L →

VIII. SUPERVISION GIVEN AND RECEIVED

4-20. Have my work frequently checked.
4-21. Solve problems by consulting others.
4-22. Am closely supervised.
4-23. Work independently.
4-24. Perform calculations alone.
4-25. Use much personal judgment.
4-26. Solve problems on own initiative.
4-27. Work with other groups.
4-28. Consult with chemists or engineers.
4-29. Consult with production personnel.
4-30. Consult with marketing personnel.
4-31. Must demonstrate leadership.
4-32. Review work schedules and revise assignments.
4-33. Assign duties to others.
4-34. Act as a working leader.
4-35. Check results of less experienced technicians.
4-36. Evaluate the performance of others.
4-37. Recommend or grant promotions.
4-38. Assist in the training of new personnel.

IX. RESULTS OF ERRORS

Errors in my work:

4-39. Are highly probable because of the job duties.
4-40. Can result in loss over $100,000.
4-41. Can result in loss over $10,000.

L →

Place ANSWER SHEET here: →

Place response on proper answer sheet. Place next to answer sheet as indicated.

COLUMN M

M →

4-42. Can result in loss over $1,000.
4-43. Can result in loss over $100.
4-44. Can result in loss of substantial business.

IX. PHYSICAL AND MENTAL DEMANDS

My job involves:

4-45. Above normal visual demand
4-46. Work involving small detail.
4-47. Long periods of concentration.
4-48. A need for analytical ability.
4-49. A need for inventive ability.
4-50. Good memory for details of previous work.
4-51. A high degree of dexterity
4-52. A high degree of accuracy.
4-53. Physical strength.
4-54. Patience.
4-55. Good memory for procedures
4-56. Working in an office area.
4-57. Working in a well-lighted, ventilated area.

XI. KNOWLEDGE, EDUCATION AND EXPERIENCE

My job requires a person with a good knowledge of:

4-58. General chemistry.
4-59. Organic chemistry.
4-60. Quantitative analytical chemistry.
4-61. Qualitative analtytical chemistry.

M →

Place ANSWER SHEET here: →

To answer Column M, place edge of answer sheet on line.

COLUMN N

N →

4-62. Physical chemistry.
4-63. Physics.
4-64. Mathematics.
4-65. Algebra.
4-66. Electricity.
4-67. Statistics.
4-68. Technical nomenclature.
4-69. Engineering terminology.

A person needs the following education for doing my job:

4-70. Less than high school education.
4-71. High school education.
4-72. One year vocational training.
4-73. Two years or more vocational training.
4-74. One to two years college.
4-75. College degree.

A person performing my job would have to have:

4-76. No experience.
4-77. Three to six months experience.
4-78. One year experience.
4-79. At least two years experience.

END OF QUESTIONNAIRE.

Thank you for your assistance.

N →

Place ANSWER SHEET here: →

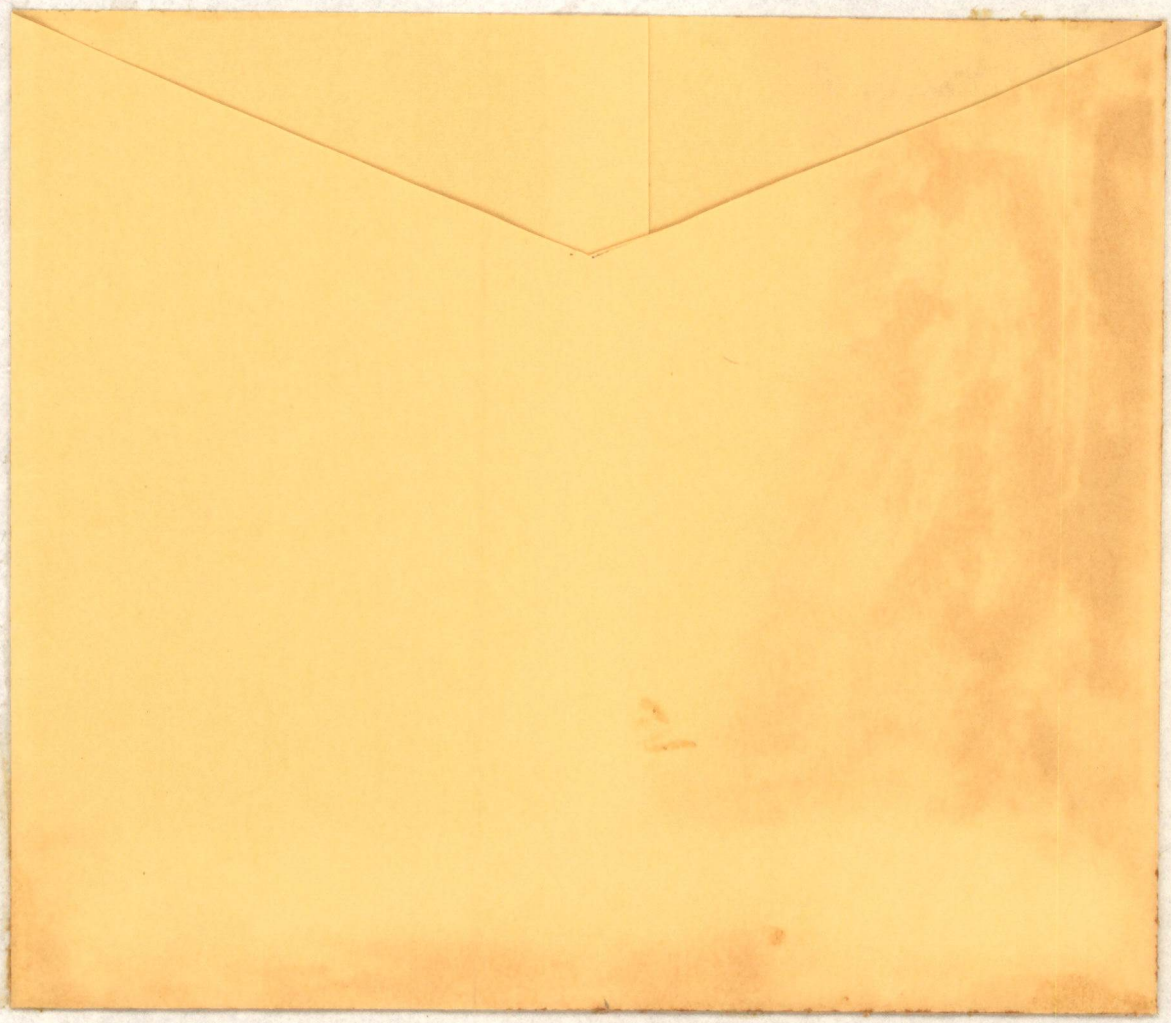


Figure 1 (continued)

-ANSWER SHEET-
COMPLETE AND RETURN THIS PORTION

Physical Testing Technicians and Supervisors are to complete the following pages. Personal data is requested on page 1 of the answer sheets. The remaining pages are to be used in conjunction with attached questionnaire pages to show the relative importance of individual job duties.

Card No. [1] (1) Respondent No. [ ][ ][ ][ ] (2 3 4 5) Company No. [ ][ ] (6 7) Location (ZIP) [ ][ ][ ] (8 9 10)

DO NOT WRITE ABOVE THIS LINE

Please Answer Every Item

NAME _____ ADDRESS _____

EMPLOYER _____ _____
City State ZIP

Circle one number

Age: [11]
1 under 25 yrs
2 25 - 34 yrs
3 35 - 44 yrs
4 over 44 yrs

Circle one number

Sex: [12]
1 Male
2 Female

Job Title: [13]
1 Trainee
2 Technician
3 Supervisor
4 Other (describe) _____

Primary Responsibility: [14]
1 Quality Control
2 Technical Service
3 Research and Development
4 Other (describe) _____

Formal Education: [15]
1 Less than high school graduate
2 High school graduate
3 1 to 2 years college
4 3 to 4 years college
5 College degree/non-technical
6 College degree/technical

Vocational Training: [16]
1 No vocational training
2 1 year vocational training
3 2 years vocational training
4 Over 2 years vocational training

I have had the following experience as a physical testing technician: [17]
1 No experience
2 Less than 6 months
3 6 months to 1 year
4 1 to 4 years
5 5 to 9 years
6 10 years or over

I work in job duties directly related to physical testing of plastics: [18]
1 Less than 25% of my time
2 25% to 50% of my time
3 50% to 75% of my time
4 75% to 100% of my time

USE THE QUESTIONNAIRE FORM TO RESPOND TO THE REMAINING ITEMS

Mail completed answer sheets to: **Plastics Survey**
The University of Tennessee
P. O. Box 9
Kingsport, Tennessee 37662

ANSWER SHEET
Complete and return this portion.

INSTRUCTIONS:

a. Place the questionnaire form on top of the answer sheet, matching the letters and arrows, as indicated.

b. CIRCLE THE PROPER ANSWER.

c. ANSWER ALL ITEMS. Do NOT leave blanks.

d. Return this portion by mail, as directed.

0 - Does not apply.
1 - Insignificant.
2 - Minor Importance.
3 - Moderate Importance.
4 - Very Important.
5 - Extremely Important.

--CIRCLE THE PROPER ANSWER--

--DO NOT LEAVE ANY BLANKS--

COLUMN A

← A

I. PLASTIC MATERIALS

1-19. 0 1 2 3 4 5
1-20. 0 1 2 3 4 5
1-21. 0 1 2 3 4 5
1-22. 0 1 2 3 4 5
1-23. 0 1 2 3 4 5
1-24. 0 1 2 3 4 5
1-25. 0 1 2 3 4 5
1-26. 0 1 2 3 4 5
1-27. 0 1 2 3 4 5
1-28. 0 1 2 3 4 5
1-29. 0 1 2 3 4 5

← A

Place Questionnaire here. ←

To answer Column B, place edge of questionnaire on line.

COLUMN B

← B

1-30. 0 1 2 3 4 5
1-31. 0 1 2 3 4 5
1-32. 0 1 2 3 4 5
1-33. 0 1 2 3 4 5
1-34. 0 1 2 3 4 5
1-35. 0 1 2 3 4 5
1-36. 0 1 2 3 4 5
1-37. 0 1 2 3 4 5
1-38. 0 1 2 3 4 5
1-39. 0 1 2 3 4 5
1-40. 0 1 2 3 4 5

II. SAMPLE PREPARATION

← B

Place Questionnaire here. ←

0 - Does not apply.
1 - Insignificant.
2 - Minor Importance.
3 - Moderate Importance.
4 - Very Important.
5 - Extremely Important.

(CIRCLE THE PROPER ANSWER)

COLUMN C

C

1-41. 0 1 2 3 4 5
1-42. 0 1 2 3 4 5
1-43. 0 1 2 3 4 5
1-44. 0 1 2 3 4 5
1-45. 0 1 2 3 4 5
1-46. 0 1 2 3 4 5
1-47. 0 1 2 3 4 5
1-48. 0 1 2 3 4 5
1-49. 0 1 2 3 4 5
1-50. 0 1 2 3 4 5
1-51. 0 1 2 3 4 5
1-52. 0 1 2 3 4 5
1-53. 0 1 2 3 4 5
1-54. 0 1 2 3 4 5
1-55. 0 1 2 3 4 5

III. TOOLS AND EQUIPMENT

1-56. 0 1 2 3 4 5
1-57. 0 1 2 3 4 5
1-58. 0 1 2 3 4 5
1-59. 0 1 2 3 4 5
1-60. 0 1 2 3 4 5
1-61. 0 1 2 3 4 5
1-62. 0 1 2 3 4 5

C

Place Questionnaire here.

To answer Column D, place edge of Questionnaire on line.

COLUMN D

D

1-63. 0 1 2 3 4 5
1-64. 0 1 2 3 4 5
1-65. 0 1 2 3 4 5
1-66. 0 1 2 3 4 5
1-67. 0 1 2 3 4 5
1-68. 0 1 2 3 4 5
1-69. 0 1 2 3 4 5
1-70. 0 1 2 3 4 5
1-71. 0 1 2 3 4 5
1-72. 0 1 2 3 4 5
1-73. 0 1 2 3 4 5
1-74. 0 1 2 3 4 5
1-75. 0 1 2 3 4 5
1-76. 0 1 2 3 4 5
1-77. 0 1 2 3 4 5
1-78. 0 1 2 3 4 5
1-79. 0 1 2 3 4 5
1-80. 0 1 2 3 4 5

2-01. 2 (Column 1, second card)
2-02. ____
2-03. ____ (Columns 02 - 05 are respondent number.)
2-04. ____
2-05. ____

2-06. 0 1 2 3 4 5
2-07. 0 1 2 3 4 5

D

Place Questionnaire here.

ANSWER SHEET

0- Does not apply.
1- Insignificant.
2- Minor importance.
3- Moderate Importance.
4- Very Important.
5- Extremely Important.

(CIRCLE THE PROPER ANSWER)

COLUMN E

E

IV. TESTS

2-08. 0 1 2 3 4 5
2-09. 0 1 2 3 4 5
2-10. 0 1 2 3 4 5
2-11. 0 1 2 3 4 5
2-12. 0 1 2 3 4 5
2-13. 0 1 2 3 4 5
2-14. 0 1 2 3 4 5
2-15. 0 1 2 3 4 5
2-16. 0 1 2 3 4 5
2-17. 0 1 2 3 4 5
2-18. 0 1 2 3 4 5
2-19. 0 1 2 3 4 5
2-20. 0 1 2 3 4 5
2-21. 0 1 2 3 4 5
2-22. 0 1 2 3 4 5
2-23. 0 1 2 3 4 5
2-24. 0 1 2 3 4 5
2-25. 0 1 2 3 4 5
2-26. 0 1 2 3 4 5
2-27. 0 1 2 3 4 5
2-28. 0 1 2 3 4 5
2-29. 0 1 2 3 4 5
2-30. 0 1 2 3 4 5
2-31. 0 1 2 3 4 5

E

Place Questionnaire here.

To answer Column F, place edge of Questionnaire on line.

COLUMN F

F

2-32. 0 1 2 3 4 5
2-33. 0 1 2 3 4 5
2-34. 0 1 2 3 4 5
2-35. 0 1 2 3 4 5
2-36. 0 1 2 3 4 5
2-37. 0 1 2 3 4 5
2-38. 0 1 2 3 4 5
2-39. 0 1 2 3 4 5
2-40. 0 1 2 3 4 5
2-41. 0 1 2 3 4 5
2-42. 0 1 2 3 4 5
2-43. 0 1 2 3 4 5
2-44. 0 1 2 3 4 5
2-45. 0 1 2 3 4 5
2-46. 0 1 2 3 4 5
2-47. 0 1 2 3 4 5
2-48. 0 1 2 3 4 5
2-49. 0 1 2 3 4 5
2-50. 0 1 2 3 4 5
2-51. 0 1 2 3 4 5
2-52. 0 1 2 3 4 5
2-53. 0 1 2 3 4 5
2-54. 0 1 2 3 4 5
2-55. 0 1 2 3 4 5
2-56. 0 1 2 3 4 5
2-57. 0 1 2 3 4 5

F

Place Questionnaire here.

0- Does not apply.
1- Insignificant.
2- Minor Importance.
3- Moderate Importance.
4- Very Important.
5- Extremely Important.

(CIRCLE THE PROPER ANSWER)

COLUMN G

2-58.	0	1	2	3	4	5
2-59.	0	1	2	3	4	5
2-60.	0	1	2	3	4	5
2-61.	0	1	2	3	4	5
2-62.	0	1	2	3	4	5
2-63.	0	1	2	3	4	5
2-64.	0	1	2	3	4	5
2-65.	0	1	2	3	4	5
2-66.	0	1	2	3	4	5
2-67.	0	1	2	3	4	5
2-68.	0	1	2	3	4	5
2-69.	0	1	2	3	4	5
2-70.	0	1	2	3	4	5
2-71.	0	1	2	3	4	5
2-72.	0	1	2	3	4	5
2-73.	0	1	2	3	4	5
2-74.	0	1	2	3	4	5
2-75.	0	1	2	3	4	5
2-76.	0	1	2	3	4	5
2-77.	0	1	2	3	4	5
2-78.m	0	1	2	3	4	5
2-79.	0	1	2	3	4	5
2-80.	0	1	2	3	4	5

3-01. 3 (Column 1, third card)
3-02. _____ (Columns 02 - 05 are respondent no.)
3-03. _____

Place Questionnaire here.

To answer Column H, place edge of Questionnaire on line.

COLUMN H

3-04. _____
3-05. _____

3-06.	0	1	2	3	4	5
3-07.	0	1	2	3	4	5
3-08.	0	1	2	3	4	5
3-09.	0	1	2	3	4	5
3-10.	0	1	2	3	4	5
3-11.	0	1	2	3	4	5
3-12.	0	1	2	3	4	5
3-13.	0	1	2	3	4	5
3-14.	0	1	2	3	4	5
3-15.	0	1	2	3	4	5
3-16.	0	1	2	3	4	5
3-17.	0	1	2	3	4	5
3-18.	0	1	2	3	4	5
3-19.	0	1	2	3	4	5
3-20.	0	1	2	3	4	5
3-21.	0	1	2	3	4	5
3-22.	0	1	2	3	4	5
3-23.	0	1	2	3	4	5
3-24.	0	1	2	3	4	5
3-25.	0	1	2	3	4	5
3-26.	0	1	2	3	4	5
3-27.	0	1	2	3	4	5
3-28.	0	1	2	3	4	5
3-29.	0	1	2	3	4	5

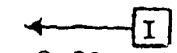
Place Questionnaire here.

ANSWER SHEET

0- Does not apply.
1- Insignificant.
2- Minor Importance.
3- Moderate Importance.
4- Very Important.
5- Extremely Important.

(CIRCLE THE PROPER ANSWER.)

COLUMN I



3-30. 0 1 2 3 4 5

3-31. 0 1 2 3 4 5

3-32. 0 1 2 3 4 5

3-33. 0 1 2 3 4 5

3-34. 0 1 2 3 4 5

3-35. 0 1 2 3 4 5

3-36. 0 1 2 3 4 5

3-37. 0 1 2 3 4 5

3-38. 0 1 2 3 4 5

3-39. 0 1 2 3 4 5

3-40. 0 1 2 3 4 5

3-41. 0 1 2 3 4 5

3-42. 0 1 2 3 4 5

3-43. 0 1 2 3 4 5

3-44. 0 1 2 3 4 5

3-45. 0 1 2 3 4 5

3-46. 0 1 2 3 4 5

3-47. 0 1 2 3 4 5

3-48. 0 1 2 3 4 5

3-49. 0 1 2 3 4 5

3-50. 0 1 2 3 4 5

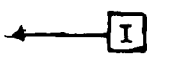
3-51. 0 1 2 3 4 5

3-52. 0 1 2 3 4 5

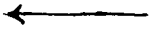
3-53. 0 1 2 3 4 5

3-54. 0 1 2 3 4 5

3-55. 0 1 2 3 4 5



Place Questionnaire here.



To answer Column J, place edge of Questionnaire on line.

COLUMN J



3-56. 0 1 2 3 4 5

3-57. 0 1 2 3 4 5

3-58. 0 1 2 3 4 5

3-59. 0 1 2 3 4 5

V. CALCULATIONS

3-60. 0 1 2 3 4 5

3-61. 0 1 2 3 4 5

3-62. 0 1 2 3 4 5

3-63. 0 1 2 3 4 5

3-64. 0 1 2 3 4 5

3-65. 0 1 2 3 4 5

3-66. 0 1 2 3 4 5

3-67. 0 1 2 3 4 5

3-68. 0 1 2 3 4 5

3-69. 0 1 2 3 4 5

3-70. 0 1 2 3 4 5

3-71. 0 1 2 3 4 5

VI. CLERICAL DUTIES

3-72. 0 1 2 3 4 5

3-73. 0 1 2 3 4 5

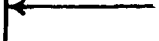
3-74. 0 1 2 3 4 5

3-75. 0 1 2 3 4 5

3-76. 0 1 2 3 4 5



Place Questionnaire here.



ANSWER SHEET

0- Does not apply.
1- Insignificant.
2- Minor Impostance.
3- Moderate importance.
4- Very important.
5- Extremely important.

(CIRCLE THE PROPER ANSWER.)

COLUMN K

3-77. 0 1 2 3 4 5

3-78. 0 1 2 3 4 5

3-79. 0 1 2 3 4 5

3-80. 0 1 2 3 4 5

4-01.	4	(Column 1, fourth card)
4-02.		
4-03.		(Columns 02 - 05 are respondent no.)
4-04.		
4-05.		

VII. RESPONSIBILITIES

4-06. 0 1 2 3 4 5

4-07. 0 1 2 3 4 5

4-08. 0 1 2 3 4 5

4-09. 0 1 2 3 4 5

4-10. 0 1 2 3 4 5

4-11. 0 1 2 3 4 5

4-12. 0 1 2 3 4 5

4-13. 0 1 2 3 4 5

4-14. 0 1 2 3 4 5

4-15. 0 1 2 3 4 5

4-16. 0 1 2 3 4 5

4-17. 0 1 2 3 4 5

4-18. 0 1 2 3 4 5

4-19. 0 1 2 3 4 5

K

Place Questionnaire here.

To answer Column L, place edge of Questionnaire on line.

COLUMN L

L

VIII. SUPERVISION GIVEN AND RECEIVED

4-20. 0 1 2 3 4 5

4-21. 0 1 2 3 4 5

4-22. 0 1 2 3 4 5

4-23. 0 1 2 3 4 5

4-24. 0 1 2 3 4 5

4-25. 0 1 2 3 4 5

4-26. 0 1 2 3 4 5

4-27. 0 1 2 3 4 5

4-28. 0 1 2 3 4 5

4-29. 0 1 2 3 4 5

4-30. 0 1 2 3 4 5

4-31. 0 1 2 3 4 5

4-32. 0 1 2 3 4 5

4-33. 0 1 2 3 4 5

4-34. 0 1 2 3 4 5

4-35. 0 1 2 3 4 5

4-36. 0 1 2 3 4 5

4-37. 0 1 2 3 4 5

4-38. 0 1 2 3 4 5

IX. RESULTS OF ERRORS

4-39. 0 1 2 3 4 5

4-40. 0 1 2 3 4 5

4-41. 0 1 2 3 4 5

L

Place Questionnaire here.

0- Does not apply.
1- Insignificant.
2- Minor Importance.
3- Moderate Importance.
4- Very Important.
5- Extremely Important.

(CIRCLE THE PROPER ANSWER BELOW)

COLUMN M

M

4-42. 0 1 2 3 4 5

4-43. 0 1 2 3 4 5

4-44. 0 1 2 3 4 5

IX. PHYSICAL AND MENTAL DEMANDS

4-45. 0 1 2 3 4 5

4-46. 0 1 2 3 4 5

4-47. 0 1 2 3 4 5

4-48. 0 1 2 3 4 5

4-49. 0 1 2 3 4 5

4-50. 0 1 2 3 4 5

4-51. 0 1 2 3 4 5

4-52. 0 1 2 3 4 5

4-53. 0 1 2 3 4 5

4-54. 0 1 2 3 4 5

4-55. 0 1 2 3 4 5

4-56. 0 1 2 3 4 5

4-57. 0 1 2 3 4 5

XI. KNOWLEDGE, EDUCATION AND EXPERIENCE

4-58. 0 1 2 3 4 5

4-59. 0 1 2 3 4 5

4-60. 0 1 2 3 4 5

4-61. 0 1 2 3 4 5

M

Place Questionnaire here:

To answer Column N, place edge of questionnaire on line.

COLUMN N

N

4-62. 0 1 2 3 4 5

4-63. 0 1 2 3 4 5

4-64. 0 1 2 3 4 5

4-65. 0 1 2 3 4 5

4-66. 0 1 2 3 4 5

4-67. 0 1 2 3 4 5

4-68. 0 1 2 3 4 5

4-69. 0 1 2 3 4 5

4-70. 0 1 2 3 4 5

4-71. 0 1 2 3 4 5

4-72. 0 1 2 3 4 5

4-73. 0 1 2 3 4 5

4-74. 0 1 2 3 4 5

4-75. 0 1 2 3 4 5

4-76. 0 1 2 3 4 5

4-77. 0 1 2 3 4 5

4-78. 0 1 2 3 4 5

4-79. 0 1 2 3 4 5

XII. ADDITIONAL NEEDS (OPTIONAL)

In addition to the prior responses, you are invited to submit comments on additional or changing needs of your jobs, at your option. Attach additional sheets, as necessary. When completed, mail answer sheets to:

Plastics Survey
The University of Tennessee
P. O. Box 9
Kingsport, Tennessee 37662

N

Place Questionnaire here.

APPENDIX C

TABLE 24

PARTICIPATING ORGANIZATIONS AND THEIR LOCATIONS
LISTED ALPHABETICALLY

Company and Location	Number of Respondents	Percent of Total Sample
Air Products and Chemicals Co., Allentown, Pa.	6	1.4
Allied Chemical Corp., Morristown, N.J.	3	0.7
A. O. Smith Corp., Milwaukee, Wisc.	3	0.7
American Can Co., Green Bay, Wisc.	1	0.2
American Chain and Cable Co., Adrian, Mich.	3	0.7
American Cyanamid Co., Stamford, Conn.	5	1.2
Amoco Chemicals Corp., Naperville, Ill.	11	2.6
Ameron Corp., West Coving, Calif.	1	0.2
Armstrong Cork Co., Lancaster, Pa.	5	1.2
Atlas Chemical Industries, Wilmington, Del.	6	1.4
Atlas Electronic Devices, Chicago, Ill.	1	0.2
Battelle Memorial Institute, Columbus, Ohio	4	1.0
BASF Wyandotte Corp., Wyandotte, Mich.	5	1.2
Belding Hemingway Co., Putnam, Conn.	2	0.5
Bell Northern Research, Ottawa, Ontario, Canada	3	0.7
Bell Telephone Laboratories, Murray Hill, N.J.	3	0.7
B. F. Goodrich Chemical Co., Avon Lake, Ohio	19	4.5
Borg Warner Corp., Washington, W. Va.	6	1.4
British Columbia Hydro and Power Authority, Vancouver, British Columbia, Canada	1	0.2
Canadian Standards Assoc., Rexdale, Ontario, Canada	1	0.2
Can-Tex Industries, Weatherford, Texas	1	0.2
Celanese Plastics Co., Hilliard, Ohio	2	0.5
Certain-Teed/St. Gobain Co., Kansas City, Kan.	2	0.5
Chemplex Co., Rolling Meadows, Ill.	9	2.1
Clow Plastics Co., Eastaboga, Ala.	2	0.5
Colorite Plastics Co., Ridgefield, N.J.	1	0.2
Congoleum Industries, Kearny, N.J.	3	0.7
C. P. Industries, Inkster, Mich.	1	0.2
Defense Supply Agency, US Govern., Philadelphia, Pa.	5	1.2

TABLE 24 (continued)

Company and Location	Number of Respondents	Percent of Total Sample
Diamond Shamrock Co., Painesville, Ohio	3	0.7
Dow Chemical Co., Midland, Mich.	18	4.3
Dow Corning Co., Midland, Mich.	3	0.7
Dynatech Research and Development Co., Cambridge, Mass.	1	0.2
Eastman Chemical Products Co., Tenn. Eastman Co., Texas Eastman Co., Kingsport, Tenn., and Longview, Texas	26	6.2
E. I. duPont deNemoirs Co., Deepwater, N.J., Wilmington, Del., Richmond, Va., Frankfort, Ohio, and Circleville, Ohio	29	6.9
Fibercast Co., Sand Springs, Okla.	4	1.0
Fiberfil, Inc., Evansville, Ind.	1	0.2
Forest Products Laboratory, Madison, Wisc.	1	0.2
Foster Grant Co., Leominster, Mass.	2	0.5
FMC Corp., Baltimore, Md.	2	0.5
General Cable Corp., Bayonee, N.J.	1	0.2
General Electric Co., Selkirk, N.Y.	1	0.2
Genova Products Co., Davison, Mich.	1	0.2
Glidden-Durke Co., Baltimore, Md.	7	1.7
Gulf Research and Development Co., Pittsburgh, Pa.	1	0.2
Goodyear Tire and Rubber Co., Akron, Ohio	1	0.2
Hercules, Inc., Wilmington, Del.	7	1.7
Hooker Chemical Co., Nitonawanda, N.Y.	2	0.5
Hysol Division, Dexter Corp., Cincinnati, Ohio	6	1.4
Independent Plastic Prods. Co., Sylvania, Ohio	2	0.5
Jim Walters Research Corp., St. Petersburg, Fla.	3	0.7
Johns-Manville Fiberglass, Inc., Waterville, Ohio	2	0.5
Kendall Co., Barrington, Ill.	2	0.5
Koch Plastics Co., Wichita, Kansas	3	0.7
M & T Chemical Co., Rahway, N.J.	2	0.5
Michigan Chemical Corp., St. Louis, Mich.	2	0.5
Michigan Consolidated Gas Co., Detroit, Mich.	1	0.2
Minneapolis Gas Co., Minneapolis, Minn.	4	1.0
Minnesota Mining and Manufacturing Co., St. Paul, Minn.	3	0.7

TABLE 24 (continued)

Company and Location	Number of Respondents	Percent of Total Sample
Mobay Chemical Co., Pittsburgh, Pa.	2	0.5
Mobil Chemical Co., Macedon, N.Y.	9	2.1
Monsanto Co., St. Louis, Mo.	9	2.1
Nalge Co., Rochester, N.Y.	1	0.2
National Sanitation Foundation, Ann Arbor, Mich.	1	0.2
New Jersey Zinc Co., Palmerton, Pa.	3	0.7
Nipak, Inc., Corsicana, Texas	1	0.2
Northern Electric Co., Ltd., Lachine, Quebec, and London, Ontario, Canada	5	1.2
Olin Plastics Co., Miami, Fla.	1	0.2
Owens-Illinois Co., Toledo, Ohio	1	0.2
The Pantasote Co., Passaic, N.Y.	3	0.7
Pennwalt Corp., King of Prussia, Pa., Bell Mahr, N.J., and Cherry Hill, N.J.	4	1.0
Philadelphia Electric Co., Philadelphia, Pa.	1	0.2
Phillips Petroleum Co., Bartlesville, Okla.	8	1.9
Plastic Wire and Cable Co., Jewett City, Conn.	3	0.7
Polymer Corp., Reading, Pa.	6	1.4
PPG Industries, Barberton, Ohio	4	1.0
Procter and Gamble Co., Cincinnati, Ohio	3	0.7
Public Service Co. of Colorado, Denver, Colo.	1	0.2
Raybestos-Manhattan Co., Mannheim, Pa.	3	0.7
R. D. Werner Co., Franklin Park, Ill.	1	0.2
Rockwell Manufacturing Co., Pittsburgh, Pa.	1	0.2
Rohm and Haas Co., Bristol, Pa.	8	1.9
Shell Chemical Co., Woodbury, N.J.	2	0.5
Simplex Wire and Cable Co., North Berwick, Maine	3	0.7
Sinclair Koppers Co., Monaca, Pa.	5	1.2
Southern California Gas Co., Los Angeles, Calif.	1	0.2
Spaulding Fibre Co., Tonowanda, N.Y.	8	1.9
Stauffer Chemical Co., Dobbs Ferry, Ill.	3	0.7
Tenneco Plastics, Inc., Edison, N.J.	1	0.2
Underwriters Laboratories, Inc., Northbrook, Ill.	6	1.4
Union Carbide Co., South Charleston, W.Va., and Oak Ridge, Tenn.	7	1.7

VITA

Robert M. Teter, Jr., was born in Clarksburg, West Virginia, on February 7, 1942. He attended elementary school in Clarksburg, West Virginia, and graduated from Washington Irving High School of that city in 1960. The following fall, he entered Virginia Polytechnic Institute, Blacksburg, Virginia, under the cooperative program and in June 1965, he received a Bachelor of Science in Chemical Engineering degree. His cooperative work experience was with Carbon Products Division, Union Carbide Corporation, Anmoore, West Virginia.

He was employed by Tennessee Eastman Company, a subsidiary of Eastman Kodak Company, in June 1965, and is currently a Chemical Engineer, Tenite Plastics Development and Control Department, Tenite Plastics Division, Kingsport, Tennessee.

He entered Graduate School at The University of Tennessee, Kingsport University Center branch, in March 1967, and is a candidate for the Master of Science degree with a major in Industrial and Personnel Management and a minor in Industrial Engineering.

He is a member of the American Institute of Chemical Engineers. He serves the Kingsport Center of Opportunity as a member of the Board of Directors. He is a member of Cassidy United Methodist Church serving as a member of the Administrative Board and Chairman of the Kindergarten and Finance Committees.

He is married to the former Arlene Miller Weeks of Radford, Virginia, and they have two children, Michael Duane and Bryan Waittman.